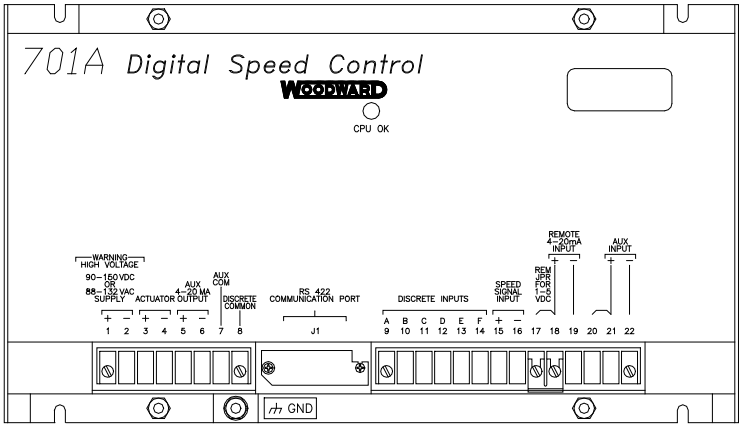
WOODWARD

Product Manual 02814
(Revision A)
Original Instructions



701A Digital Speed Control for Reciprocating Engines

8280-192, 8280-193, 8280-194

Installation and Operation Manual

IMPORTANT

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DEFINITIONS

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the *publications page* on the Woodward website:

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Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

NOTICE

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Revisions—Text changes are indicated by a black line alongside the text.

Contents

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Illustrations and Tables

Regulatory Compliance

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

⚠WARNING

EXPLOSION HAZARD—Substitution of components may impair suitability for Class I, Division 2.

Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe 1, Division 2.

Avant de déconnecter l'équipement, coupler le courant ou s'assurer que l'emplacement est désigné non dangereux.

IMPORTANT

Installation wiring must be in accordance with Class I, Division 2 wiring methods in Article 501-4(b) of the NEC, and in accordance with the authority having jurisdiction.

IMPORTANT

All peripheral equipment must be suitable for the location in which used.

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

    - Do not touch any part of the PCB except the edges.

    - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.

    - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Chapter 1.
General Information

Introduction

This manual describes the Woodward 701A Digital Speed Control, models 8280-192, 8280-193, and 8280-194.

Declaration of Incorporation

In accordance with the EMC Directive 89/336/EEC and its amendments, this controlling device, manufactured by the Woodward Governor Company, is applied solely as a component to be incorporated into an engine prime mover system. Woodward declares that this controlling device complies with the requirements of EN50081-2 and EN50082-2 when put into service per the installation and operating instructions outlined in the product manual.

IMPORTANT **This controlling device is intended to be put into service only upon incorporation into an engine prime mover system that itself has met the requirements of the above Directive and bears the CE mark.**

Application

The 701A Digital Speed Control controls the speed of reciprocating engines in mechanical drive or generator set service. The control includes an input for a 4 to 20 mA remote speed reference setting, an internal speed reference for local control of speed, and an auxiliary voltage input for load sensor connection in load sharing applications.

The 701A control system includes:
- a 701A Digital Speed Control;
- an external power source;
- a speed-sensing device;
- a proportional actuator to position the fuel rack;
- a terminal for adjusting control parameters;
- an optional load sensing device.

The 701A control (Figure 1-1) consists of a single printed circuit board in a sheet-metal chassis. Connections are via two terminal strips and a 9-pin subminiature D connector.

Control Options

The 701A control provides the following power supply input voltages, with 8 watts as the nominal power consumption at rated voltage:
- 18-40 Vdc (24 or 32 Vdc nominal; low-voltage control);
- 88-132 Vac 45-65 Hz (120 Vac nominal; high-voltage control);
- 90-150 Vdc (125 Vdc nominal; high-voltage control).

Discrete input voltages provide on/off command signals to the electronic control, such as Raise Speed, Lower Speed, etc. Each discrete input requires 10 mA at its nominal voltage rating:

- 24 Vdc where 24 volts is used for switching logic;
- internal auxiliary voltage provided on the control for use on high voltage versions of the 701A control in systems where 24 Vdc switching logic voltage is unavailable (dry contact switches or relays must be used).

Other available options are:

- proximity switch input for speed signal frequencies below 100 Hz;
- tandem actuator outputs;
- speed filter.

These models of the 701A Digital Speed Control are available with the following option combinations. The part number is stamped on the identification tag on the front of the control.

Part Number	Speed Input	Power Supply Voltage	Actuator Current	Speed Range
8280-192	Mag. Pickup	Low	0-200 mA	8-2100 rpm
8280-193	Mag. Pickup	High	0-200 mA	8-2100 rpm
8280-194	Mag. Pickup	Low	0-20 mA	8-2100 rpm

The magnetic pickup versions are limited to operating speeds providing 60 Hz magnetic pickup frequency minimum.

701A Digital Speed Control Accessories

Hand Held Programmer (Figure 1-2), part number 9907-205, is used for adjusting the 701A control. It plugs into the serial port of the control.

Generator Load Sensor, for load sharing or droop-parallel generator applications.

SPM-A Synchronizer, for synchronizing the generator phase to that of the power bus. The synchronizer generates a close generator breaker signal to parallel the generator with the power bus.

Power Output Sensor, for load sharing or droop operation in mechanical load applications.

Real Power Sensor, for load sharing or droop-parallel generator applications.

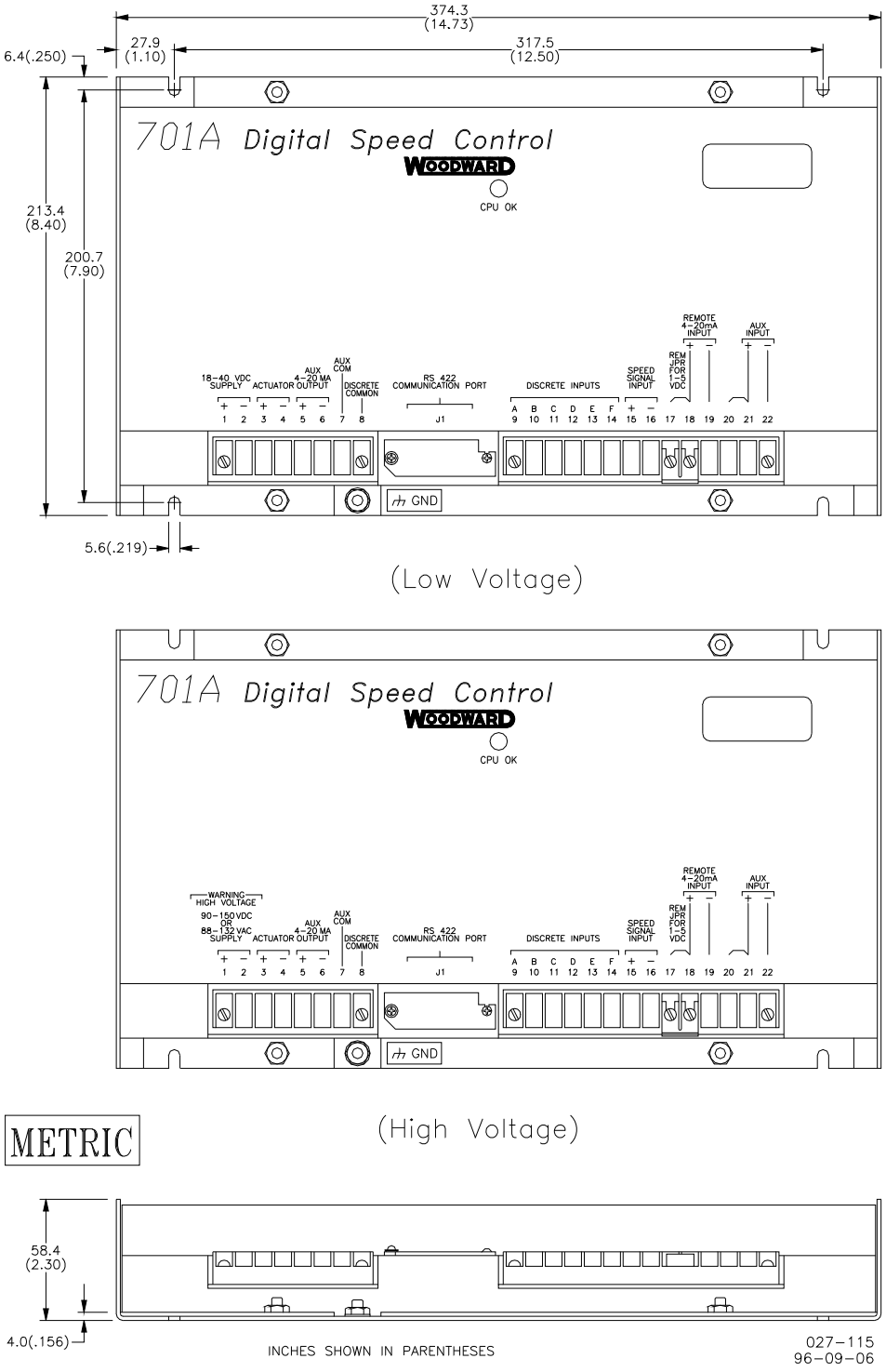


Figure 1-1. 701A Digital Speed Control

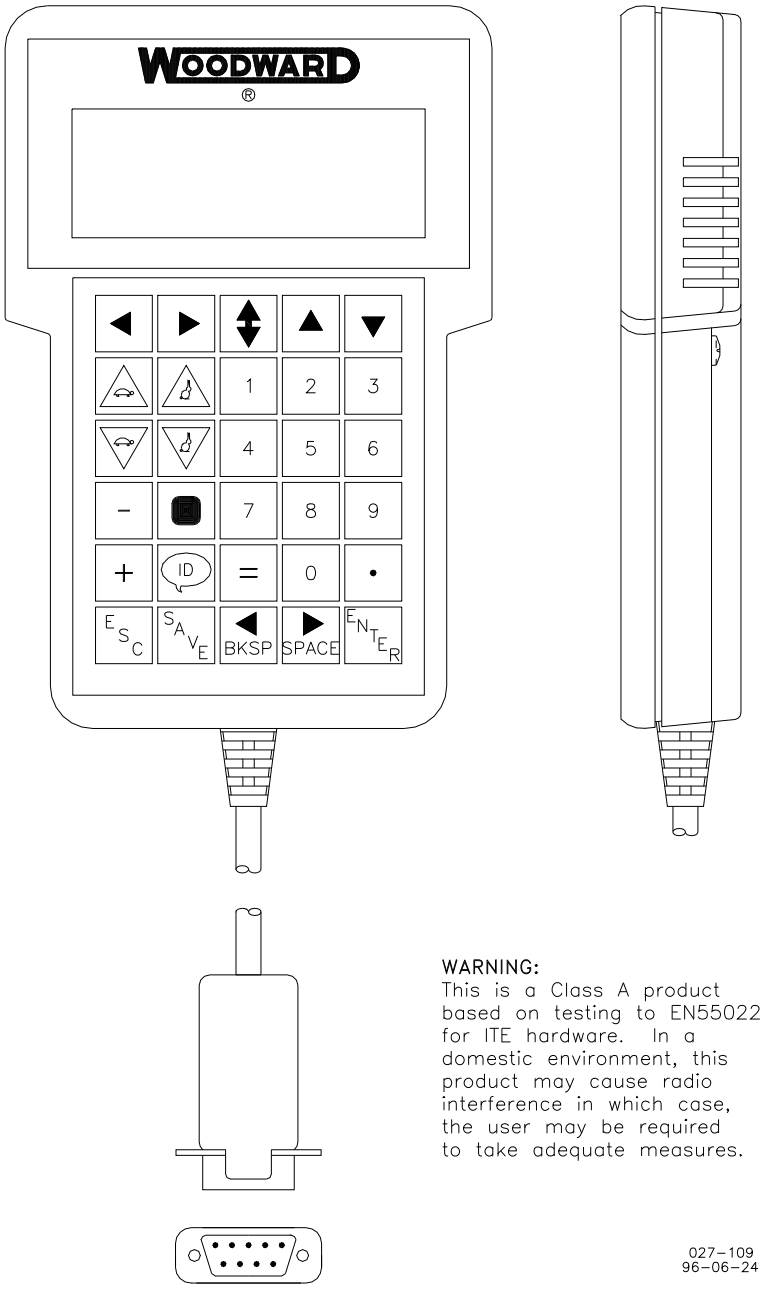
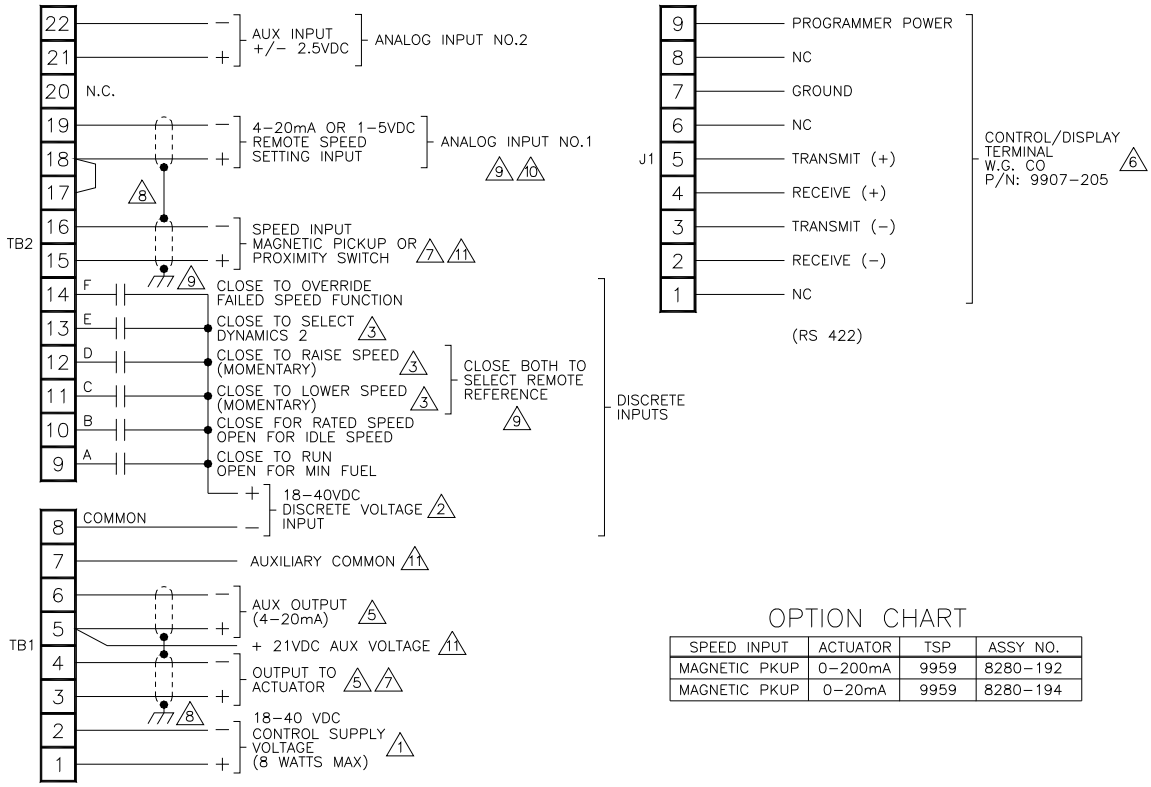


Figure 1-2. Hand Held Programmer



OPTION CHART

SPEED INPUT	ACTUATOR	TSP	ASSY NO.
MAGNETIC PKUP	0-200mA	9959	8280-192
MAGNETIC PKUP	0-20mA	9959	8280-194

NOTES:

1. INTERNAL POWER SUPPLY PROVIDES DC ISOLATION BETWEEN THE POWER SOURCE AND ALL OTHER INPUTS AND OUTPUTS.
2. DISCRETE INPUTS ARE OPTICALLY ISOLATED FROM OTHER CIRCUITS. INPUT CURRENT IS NOMINALLY 10 MILLIAMPS PER INPUT INTO 2100 OHMS.
3. WHEN DYNAMICS 2 IS SELECTED (DISCRETE INPUT E HAS VOLTAGE APPLIED) GAIN 2. RESET 2 AND COMPENSATION 2 ARE USED FOR CONTROL PARAMETERS. WHEN INPUT IS OPEN, GAIN 1 ETC. CONTROL PARAMETERS ARE USED.
4. DO NOT MAKE CONNECTIONS TO TERMINALS MARKED N.C.
5. WHILE THE CONTROL CIRCUITS ARE ISOLATED FROM THE POWER SOURCE, ANALOG INPUTS AND OUTPUTS ARE NOT ISOLATED FROM EACH OTHER. ISOLATORS ARE AVAILABLE FROM A NUMBER OF MANUFACTURERS. CONTACT WOODWARD GOVERNOR COMPANY FOR FURTHER INFORMATION.
6. THE RS422 SERIAL PORT IS SET UP TO INTERFACE WITH THE WOODWARD GOVERNOR CO. P/N 9907-205 CONTROL/ DISPLAY TERMINAL. THIS PORT IS COMPATIBLE WITH OTHER TERMINALS SUPPORTING RS422. INFORMATION ON UTILIZING OTHER DEVICES ON THE SERIAL PORT IS CONTAINED IN THE USERS MANUAL.
7. SEE OPTION CHART.
8. SHIELDED WIRES TO BE TWISTED PAIRS WITH SHIELD GROUNDED AT ONE END ONLY. WHEN MOUNTING CONTROL TO BULKHEAD, USE EXTERNAL TOOTH LOCK WASHER UNDER ONE SCREWHEAD TO ENSURE PROPER GROUNDING. A GROUND STUD IS PROVIDED ON THE CHASSIS.
9. WHEN REMOTE REFERENCE IS SELECTED (DISCRETE INPUTS "C" AND "D" HAVE VOLTAGE APPLIED), THE RAISE AND LOWER SPEED INPUTS ARE DISABLED. THE SPEED REFERENCE SETTING IS BASED ON THE VALUE OF CURRENT IN THE REMOTE SPEED REFERENCE INPUT. WHEN REMOTE REFERENCE IS NOT SELECTED (DISCRETE INPUTS"C" AND "D" ARE OPEN), THE RAISE AND LOWER SPEED INPUTS ARE ENABLED.
10. REMOVE JUMPER FOR 1-5VDC REMOTE SPEED SETTING INPUT.
11. POWER FOR A PROXIMITY SWITCH MAY BE OBTAINED FROM TERMINALS 5(+) AND 7(-). THE SWITCH MUST BE SUITABLE FOR +21V POWER. THE PROXIMITY SWITCH MUST NOT DRAW MORE THAN 190 mA.

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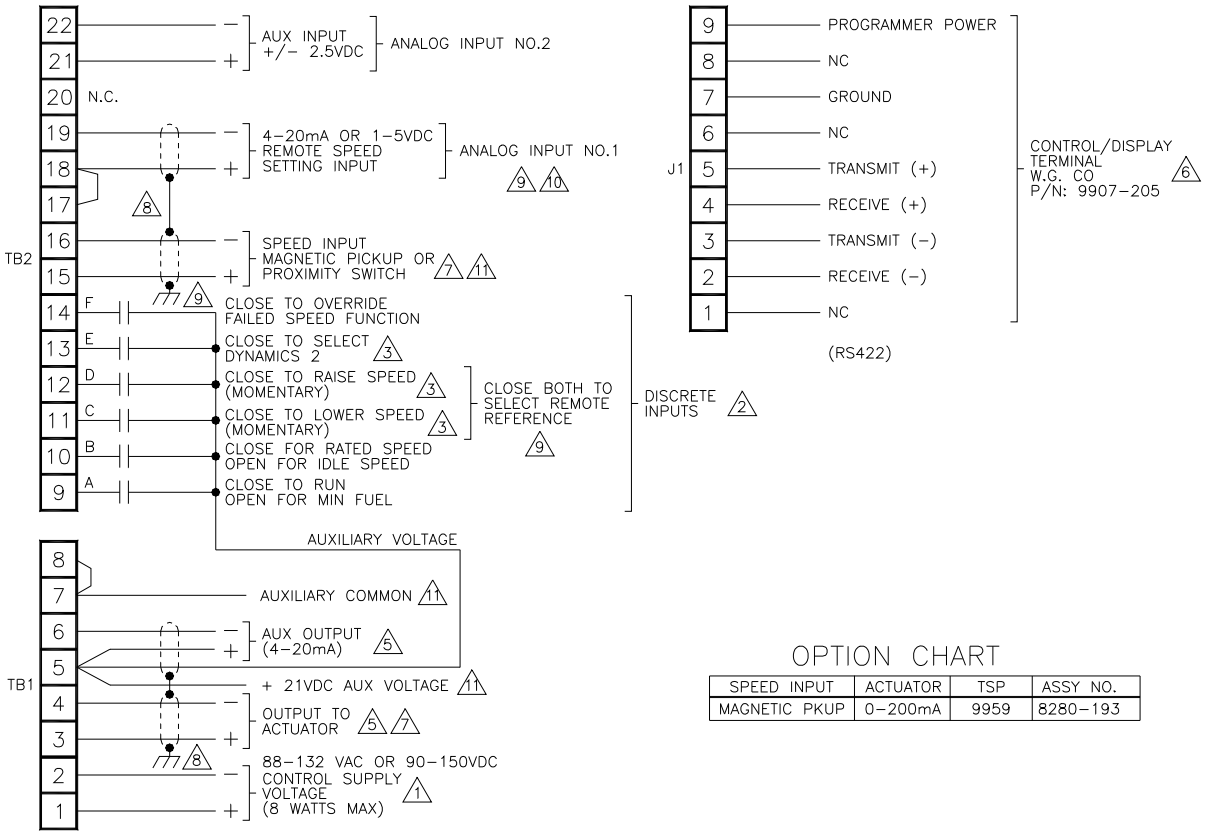
Figure 1-3a. Plant Wiring Diagram (low voltage power supply)



OPTION CHART

SPEED INPUT	ACTUATOR	TSP	ASSY NO.
MAGNETIC PKUP	0-200mA	9959	8280-193

NOTES:

1. INTERNAL POWER SUPPLY PROVIDES DC ISOLATION BETWEEN THE POWER SOURCE AND ALL OTHER INPUTS AND OUTPUTS.
2. DISCRETE INPUTS ARE OPTICALLY ISOLATED FROM OTHER CIRCUITS. INPUT CURRENT IS NOMINALLY 10 MILLIAMPS PER INPUT INTO 2100 OHMS.
3. WHEN DYNAMICS 2 IS SELECTED (DISCRETE INPUT E HAS VOLTAGE APPLIED) GAIN 2. RESET 2 AND COMPENSATION 2 ARE USED FOR CONTROL PARAMETERS. WHEN INPUT IS OPEN, GAIN 1 ETC. CONTROL PARAMETERS ARE USED.
4. DO NOT MAKE CONNECTIONS TO TERMINALS MARKED N.C.
5. WHILE THE CONTROL CIRCUITS ARE ISOLATED FROM THE POWER SOURCE, ANALOG INPUTS AND OUTPUTS ARE NOT ISOLATED FROM EACH OTHER. ISOLATORS ARE AVAILABLE FROM A NUMBER OF MANUFACTURERS. CONTACT WOODWARD GOVERNOR COMPANY FOR FURTHER INFORMATION.
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7. SEE OPTION CHART.
8. SHIELDED WIRES TO BE TWISTED PAIRS WITH SHIELD GROUNDED AT ONE END ONLY. WHEN MOUNTING CONTROL TO BULKHEAD, USE EXTERNAL TOOTH LOCK WASHER UNDER ONE SCREWHEAD TO ENSURE PROPER GROUNDING. A GROUND STUD IS PROVIDED ON THE CHASSIS.
9. WHEN REMOTE REFERENCE IS SELECTED (DISCRETE INPUTS "C" AND "D" HAVE VOLTAGE APPLIED), THE RAISE AND LOWER SPEED INPUTS ARE DISABLED. THE SPEED REFERENCE SETTING IS BASED ON THE VALUE OF CURRENT IN THE REMOTE SPEED REFERENCE INPUT. WHEN REMOTE REFERENCE IS NOT SELECTED (DISCRETE INPUTS"C" AND "D" ARE OPEN), THE RAISE AND LOWER SPEED INPUTS ARE ENABLED.
10. REMOVE JUMPER FOR 1-5VDC REMOTE SPEED SETTING INPUT.
11. POWER FOR A PROXIMITY SWITCH MAY BE OBTAINED FROM TERMINALS 5(+) AND 7(-). THE SWITCH MUST BE SUITABLE FOR +21V POWER. THE PROXIMITY SWITCH MUST NOT DRAW MORE THAN 190 mA.

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Figure 1-3b. Plant Wiring Diagram (high voltage power supply)

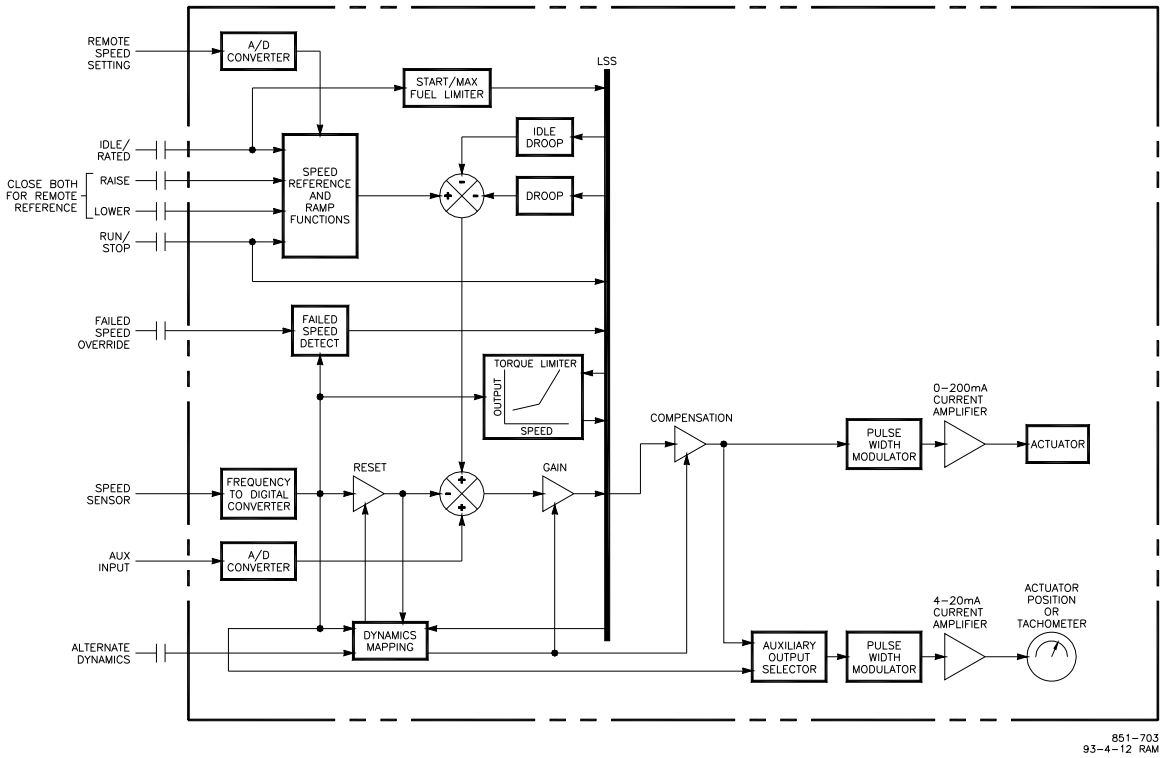

Figure 1-4. Block Diagram

Chapter 2. Installation

Introduction

This chapter contains general installation instructions for the 701A control. Power requirements, environmental precautions, and location considerations are included to help you determine the best location for the control. Additional information includes unpacking instructions, electrical connections, and installation checkout procedures.

Unpacking

Before handling the control, read page iv, Electrostatic Discharge Awareness. Be careful when unpacking the electronic control. Check the control for signs of damage such as bent panels, scratches, and loose or broken parts. If any damage is found, immediately notify the shipper.

Power Requirements

The high-voltage versions of the 701A Digital Speed Control require a voltage source of 88 to 132 Vac 45 to 65 Hz or 90 to 150 Vdc. The low-voltage versions require a voltage source of 18 to 40 Vdc.

NOTICE **To prevent damage to the control, do not exceed the input voltage range.**

IMPORTANT **If a battery is used for operating power, an alternator or other battery-charging device is necessary to maintain a stable supply voltage.**

NOTICE **To prevent damage to the control, make sure that the alternator or other battery-charging device is turned off or disconnected before disconnecting the battery from the control.**

Location Considerations

Consider these requirements when selecting the mounting location:

- adequate ventilation for cooling;
- space for servicing and repair;
- protection from direct exposure to water or to a condensation-prone environment;
- protection from high-voltage or high-current devices, or devices which produce electromagnetic interference;
- avoidance of vibration;
- selection of a location that will provide an operating temperature range of -40 to +70 °C (-40 to +158 °F).

The control must NOT be mounted on the engine.

Electrical Connections

External wiring connections and shielding requirements for a typical control installation are shown in the plant wiring diagram, Figure 1-3. The plant wiring connections are explained in the rest of this chapter.

Shielded Wiring

All shielded cable must be twisted conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the nearest chassis ground. Wire exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches). The other end of the shields must be left open and insulated from any other conductor. DO NOT run shielded signal wires along with other wires carrying large currents. See Woodward application note 50532, *Interference Control in Electronic Governing Systems* for more information.

Where shielded cable is required, cut the cable to the desired length and prepare the cable as instructed below.

1. Strip outer insulation from BOTH ENDS, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.

2. Using a sharp, pointed tool, carefully spread the strands of the shield.

3. Pull inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.

4. Remove 6 mm (1/4 inch) of insulation from the inner conductors.

Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Power Supply

Power supply output must be low impedance (for example, directly from batteries). DO NOT power low-voltage versions of the control from high-voltage sources with resistors and zener diodes in series with the control power input. The 701A control contains a switching power supply which requires a current surge to start properly.

NOTICE **To prevent damage to the control, do not power low-voltage versions of the control from high-voltage sources.**

Run the power leads directly from the power source to the control. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL. Avoid long wire lengths. Connect the positive (line) to terminal 1 and negative (common) to terminal 2. If the power source is a battery, be sure the system includes an alternator or other battery-charging device.

If possible, do NOT turn off control power as part of a normal shutdown procedure. Use the Minimum Fuel discrete input (terminal 9) for normal shutdown. Leave the control powered except for service of the system and extended periods of disuse.

NOTICE

Do NOT apply power to the control at this time. Applying power may damage the control.

NOTICE

To prevent damage to the engine, apply power to the 701A control at least ten seconds prior to starting the engine. The control must have time to do its power up diagnostics and become operational. Do not start the engine if the diagnostic tests fail, because test failure turns off the output of the control.

Actuator Output

The actuator wires connect to terminals 3(+) and 4(-). Use shielded wires with the shield connected to chassis at the control.

Aux Output

The tachometer or actuator position readout wires connect to terminals 5(+) and 6(-). Use shielded twisted-pair wires. For an electrically isolated input device such as a 4 to 20 mA input analog meter, the shield should be grounded at the control end of the cable. For input to other devices, use the recommendation of the device manufacturer.

NOTICE

To prevent possible damage to the control or poor control performance resulting from ground loop problems, follow these instructions. The control common is electrically isolated from the power supply input; however, the actuator and aux outputs are current sources and have a common mode voltage on them with respect to the control's internal common (terminal 7 - Aux Common). The analog inputs to the control use this same common. Connecting the actuator or aux outputs to external circuits that are not isolated from the remote speed setting 4 to 20 mA current source will create ground loop problems. We recommend using current-loop isolators if the 701A control's analog inputs and outputs must both be used with non-isolated devices. A number of manufacturers offer 20 mA loop isolators. Consult Woodward for further information.

Discrete Inputs

Discrete inputs are the switch input commands to the 701A control. In low voltage systems, or other systems where nominal 24 Vdc is available, the discrete inputs should be powered by this external voltage.

If you are using the control-supplied aux voltage, which is recommended only for high voltage systems where 24 Vdc is not available, jumper terminal 7 to terminal 8. This connects the control's common to the discrete input common. Terminal 5 then supplies power (approximately +21 Vdc) to the discrete inputs. Since the aux voltage is not isolated from other control circuits, use only isolated contacts (dry or signal voltage rated) for the discrete circuits. DO NOT POWER ANY OTHER DEVICES WITH THE AUX VOLTAGE SOURCE.

If you are supplying the discrete input voltage (24 Vdc), connect the voltage source negative (-) to terminal 8. Then run the voltage source positive (+) to the appropriate switch or relay contact and then to the corresponding discrete input.

Minimum Fuel Contact

The minimum-fuel contact is the preferred means for a normal shutdown of the engine. It connects to terminal 9, Discrete Input A, of the control. The control will not operate without voltage applied to terminal 9. When the contact is closed, the voltage applied to terminal 9 allows the control to move the actuator to any position required for operating conditions.

⚠WARNING

The minimum-fuel contact is not intended for use in any emergency stop sequence. To prevent possible serious injury from an overspeeding engine, do NOT use the minimum-fuel contact as part of any emergency stop sequence.

Idle/Rated Contact

The Idle/Rated contact (open for Idle, closed for Rated) connects to terminal 10, Discrete Input B. This contact also determines which fuel limiter is in effect. In Idle, the control uses the Start Fuel Limit set point. In Rated, the control uses the Maximum Fuel Limit set point or Torque Limit schedule. When the Idle/Rated contact is closed, the control immediately switches the fuel limit to the maximum limit and ramps engine speed to the rated speed set point (or the speed specified by the Remote Input when the Remote Speed Setting input is enabled). When the Idle/Rated contact is opened, the control immediately switches on the Start Fuel Limit and ramps engine speed to the idle speed setting.

The idle set point cannot be set above the rated set point. The fuel limiters (start or maximum) remain effective regardless of the Local/Remote input.

Lower Speed Contact

The Lower Speed contact connects to terminal 11, Discrete Input C. When the Lower Speed contact is closed, the control lowers speed at a rate determined by the Lower Rate set point. When the contact is open, speed remains at its current value. Actuating the Lower Speed contact will cancel the ramps started by the Idle/Rated contact.

The Lower Speed contact input is disabled when the Remote Speed Setting mode is selected by closing both the Lower Speed and Raise Speed contacts.

Raise Speed Contact

The Raise Speed contact connects to terminal 12, Discrete Input D. When the Raise Speed contact is closed, the control raises speed at a rate determined by the Raise Rate set point. When the contact is open, speed remains at its current value. Actuating the Raise Speed contact will cancel the ramps started by the Idle/Rated contact.

The Raise Speed contact input is disabled when the Remote Speed Setting mode is selected by closing both the Lower Speed and Raise Speed contacts.

Alternate Dynamics

The Alternate Dynamics contact connects to terminal 13, Discrete Input E. When this contact is open, Dynamics set 1 is selected. When this contact is closed, Dynamics set 2 is selected.

Failed Speed Signal Override

The Failed Speed Signal Override is connected to terminal 14, Discrete Input F. When the contact is open, the control operates normally, turning the control output to minimum fuel in the event of a loss of speed signal.

Closing the contact overrides the failed speed signal function, which may be required for start-up. Prior to engine start-up, the speed signal is nonexistent. On engines requiring fuel during cranking, the Failed Speed Signal Override allows the actuator to open and provide fuel for starting.

Speed Signal Input

Connect a speed-sensing device, such as a magnetic pickup, to terminals 15 and 16 using shielded wire. Connect the shield to the chassis. Make sure the shield has continuity the entire distance to the speed sensor, and make sure the shield is insulated from all other conducting surfaces.

⚠WARNING

The number of gear teeth is used by the control to convert pulses from the speed sensing device to engine rpm. To prevent possible serious injury from an overspeeding engine, make sure the control is properly programmed to convert the gear-tooth count into engine rpm. Improper conversion could cause engine overspeed.

Remote Speed Setting Input

Connect the 4 to 20 mA current transmitter or 1 to 5 Vdc voltage transmitter to terminals 18(+) and 19(-). Use a shielded, twisted-pair cable. When using a 4 to 20 mA transmitter, you must install a jumper between terminals 17 and 18 to connect a 243 ohm burden resistor in the loop. This input is not isolated from the other control inputs and outputs (except the power supply input and the discrete inputs). If any other analog input or output is used in a common ground system, an isolator must be installed. A number of manufacturers offer 20 mA loop isolators. Consult Woodward for further information.

Aux Voltage Input

Connect the output of a Woodward Load Sensor to terminals 21(+) and 22(-). Use a shielded twisted-pair cable. Wire the remainder of the load sensor in accordance with the wiring diagram for the sensor used.

Installation Checkout Procedure

With the installation complete as described in this chapter, do the following checkout procedure before beginning set point entry (Chapter 3) or initial start-up adjustments (Chapter 4).

1. Visual inspection

   A. Check the linkage between the actuator and fuel metering device for looseness or binding. Refer to the appropriate actuator manual, and Manual 25070, *Electric Governor Installation Guide* for additional information on linkage.

⚠WARNING **To prevent possible serious injury from an overspeeding engine, the actuator lever or stroke should be near but not at the minimum position when the fuel valve or fuel rack is at the minimum fuel delivery position.**

   B. Check for correct wiring in accordance with the Plant Wiring Diagram, Figure 1-3.

   C. Check for broken terminals and loose terminal screws.

   D. Check the speed sensor for visible damage. If the sensor is a magnetic pickup, check the clearance between the gear and the sensor, and adjust if necessary. Clearance should be between 0.25 and 1.25 mm (0.010 and 0.050 inch) at the closest point. Make sure the gear runout does not exceed the pickup gap.

2. Check for grounds

   Check for grounds by measuring the resistance from all control terminals to chassis. All terminals except terminals 2 and 8 should measure infinite resistance (the resistance of terminals 2 and 8 depends on whether a floating or grounded power source is used). If a resistance less than infinite is obtained, remove the connections from each terminal one at a time until the resistance is infinite. Check the line that was removed last to locate the fault.

Chapter 3.
Entering Control Set Points

Introduction

Because of the variety of installations, plus system and component tolerances, the control must be tuned to each system for optimum performance.

This chapter contains information on how to enter control set points through the control's menu system using the Hand Held Programmer. See the next chapter for prestart-up and start-up settings and adjustments.

⚠WARNING

An improperly calibrated control could cause an engine overspeed or other damage to the engine. To prevent possible serious injury from an overspeeding engine, read this entire procedure before starting the engine.

Hand Held Programmer and Menus

The Hand Held Programmer is a hand-held computer terminal that gets its power from the 701A control. The terminal connects to the RS-422 communication serial port on the control (terminal J1). To connect the terminal, slightly loosen the right-hand screw in the cover over J1 and rotate the cover clockwise to expose the 9-pin connector. Then firmly seat the connector on the terminal into J1.

The programmer does a power-up self-test whenever it is plugged into the control. When the self-test is complete, the screen will be blank. Press the “ID” key to display the part number and revision level of the software in the control. Refer to this number and revision level in any correspondence with Woodward (write this information in the Appendix).

The set points or adjustments of the control are arranged in nine menus. You access these menus with the number keys (1, 2, 3, 4, 5, 6, 7, 9, 0). Pressing the appropriate key selects the first item on each menu.

The programmer screen is a four-line, backlit LCD display. The display permits you to look at two separate functions or menu items at the same time. Use the “Up/Down Arrow” key to toggle between the two displayed items (the first letter of the active menu item will blink).

The programmer keys do the following functions (see Figure 3-1):

(left arrow)	Moves backward through each menu, one step at a time.
(right arrow)	Advances through each menu, one step at a time.
(up/down arrow)	Toggles between the two displayed items (the first letter of the active menu item will blink).
(up arrow)	Same function as left arrow.
(down arrow)	Same function as right arrow.
(turtle up)	Increases the displayed set point value slowly.
(turtle down)	Decreases the displayed set point value slowly.
(rabbit up)	Increases the displayed set point value quickly (about 10 times faster than the turtle keys).
(rabbit down)	Decreases the displayed set point value quickly (about 10 times faster than the turtle keys).
– (minus)	Not used.
+ (plus)	Not used.
■ (solid square)	Blanks the display. Updates display in Menus 7 and 9.
ID	Displays the 701A control part number and software revision level.
ESC	Not used.
SAVE	Saves entered values (set points).
BKSP	Not used.
SPACE	Not used.
ENTER	Not used.
= (equals)	Not used.
(decimal)	Not used.
1	Selects Menu 1.
2	Selects Menu 2.
3	Selects Menu 3.
4	Selects Menu 4.
5	Selects Menu 5.
6	Selects Menu 6.
7	Selects Menu 7.
8	Not used.
9	Selects Menu 9.
0	Selects Menu 0.

	Name	Min. Value	Max. Value	Step Size	Initial Value	Dimen-sion
Menu 1 – Dynamics Menu						
1.	Gain 1	0.0002	10.000	0.001	0.050	
2.	Stability 1	0.00	10.00	0.01	1.0	seconds
3.	Compensation 1	0.00	10.00	0.01	0.20	seconds
4.	Gain Ratio 1	1.0	50.0	0.1	1.0	
5.	Window Width 1	0	2100	1	60	rpm
6.	Gain Breakpoint 1	0	100	1	25	% actuator
7.	Gain Slope 1	–50.0	+50.0	0.1	0.0	

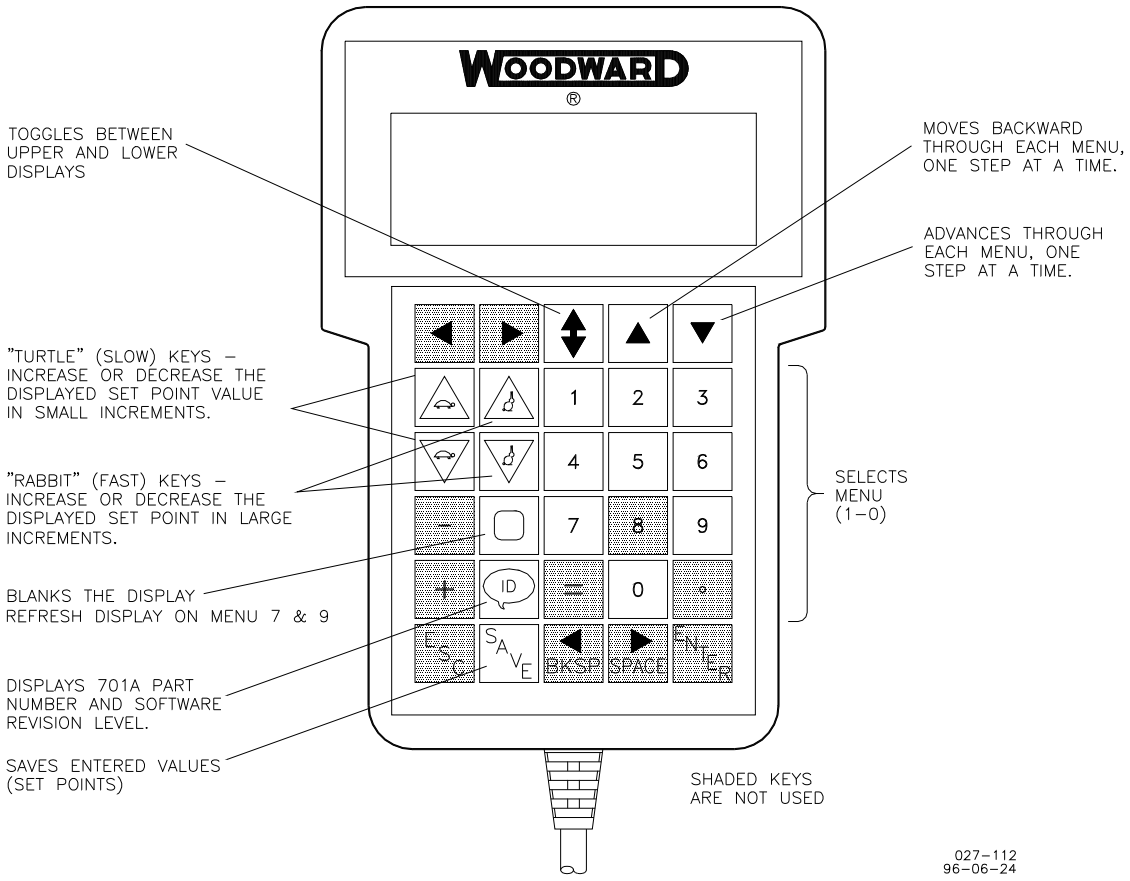

Figure 3-1. Hand Held Programmer Functions

	Name	Min. Value	Max. Value	Step Size	Initial Value	Dimension
Menu 2 – Alternate Dynamics Menu						
1.	Gain 2	0.00015	10.000	0.001	0.050	
2.	Stability 2	0.00	10.00	0.01	1.0	seconds
3.	Compensation 2	0.00	10.00	0.01	0.20	seconds
4.	Gain Ratio 2	1.0	50.0	0.1	1.0	
5.	Window Width 2	0	2100	1	60	rpm
6.	Gain Breakpoint 2	0	100	1	25	% actuator
7.	Gain Slope 2	–50.0	+50.0	0.1	0.0	

	Name	Min. Value	Max. Value	Step Size	Initial Value	Dimen-sion
Menu 3 — Speed Setting Menu						
1.	Raise Limit	rated speed	2100	1	1200	rpm
2.	Lower Limit	8	raise spd lim	1	400	rpm
3.	Idle Speed	8	rated speed	1	400	rpm
4.	Accel Time	0	500	1	20	seconds
5.	Decel Time	0	500	1	20	seconds
6.	Raise Rate	0	32 000	1	100	rpm/minute
7.	Lower Rate	0	32 000	1	100	rpm/minute
8.	20ma Remote Ref	lwr spd lim	raise spd lim	1	1200	rpm
9.	4ma Remote Ref	lwr spd lim	raise spd lim	1	400	rpm
10.	20 ma Tach RPM	–500	32 000	1	2000	rpm
11.	4 ma Tach RPM	–500	32 000	1	400	rpm
12.	Droop	0	100	0.1	0	%
13.	Idle Breakpoint	0	100	1	25	% actuator
14.	Idle Droop	0	100	1	0	%
15.	Torsional Filter	0.00	1.00	0.01	0.1	
Menu 4 — Fuel Limiters and Control Output Menu						
1.	Max Fuel Limit	0	100	1	0	% actuator
2.	Start Fuel Limit	0	100	1	0	% actuator
3.	Start Speed	0	idle speed	1	100	rpm
4.	Idle Fuel Limit	0	100	1	0	%
5.	Torque Limit BP	lower limit	raise limit	1	1000	rpm
6.	Min Torque Limit	0	100	1	100	% actuator
7.	BP Torque Limit	0	100	1	100	% actuator
8.	Max Torque Limit	0	100	1	100	% actuator
9.	20ma Aux Actuator	0	100	1	100	% actuator
10.	4ma Aux Actuator	0	100	1	0	% actuator
Menu 5 — Configuration Menu						
1.	Configuration Key	0	100	1	0	
2.	Rated Speed	idle speed	raise spd lim	1	1000	rpm
3.	Num Gear Teeth	1	500	1	60	
4.	Num Samples	1	60	1	6	
5.	Engine Type (2-Stroke or 4-Stroke)				2-Stroke	
6.	Actuator Sense (Forward Acting, Reverse Acting)				Forward Acting	
7.	Dynamics Map (Linear, Non-Linear)				Linear	
8.	Remote Fault (Lock-In-Last, 4.0mA Setpoint)				Lock-In-Last	
9.	Speed Sense (Adaptive, Non-Adaptive)				Non-Adaptive	
10.	Aux Output (Tachometer, Actuator Percent)				Tachometer	

	Name	Displayed Value
Menu 6 — Calibration Menu		
1.	Calibration Key	[actual value]
2.	Remote In Cal	[actual value]
3.	Aux Input Cal	[actual value]
4.	Aux Output Cal	[actual value]

Menu 7 — Display Menu 1

1.	Engine Speed	rpm
2.	Speed Reference	rpm
3.	Actuator Output	%
4.	Aux Output	mA
5.	Remote Input	mA
6.	Aux Input	volts
7.	Control Mode	Stop/Failsafe/Fuel Limiter/Speed Control

[There is no Menu 8.]

Menu 9 — Display Menu 2

1.	Run/Stop Contact	open/closed
2.	Idle / Rated	open/closed
3.	Lower Speed	open/closed
4.	Raise Speed	open/closed
5.	Dynamics Switch	open/closed
6.	Failsafe Override	open/closed

Menu 0 — Diagnostics

1.	Watchdog Status	OK
2.	Diagnostics Results	49
3.	ROM Checksum	[variable with application]

Pressing the appropriate number key (1, 2, 3, 4, 5, 6, 7, 9, 0) selects the desired menu. To step through the menu, use the “Up Arrow” and “Down Arrow” keys (the “Left Arrow” and “Right Arrow” keys perform the same functions). The “Down Arrow” key advances through the menu and the “Up Arrow” key moves backward through the menu. The menus are continuous; that is, pressing the “Down Arrow” at the last menu item takes the menu to the first item, or pressing the “Up Arrow” at the beginning of the menu takes the menu to the last item.

To adjust a set point, use the “Turtle Up” or the “Rabbit Up” keys to increase the value, and the “Turtle Down” or “Rabbit Down” keys to decrease the value. The “Rabbit Up” and “Rabbit Down” keys will make the rate of change faster than the “Turtle Up” and “Turtle Down” keys. This is useful during initial setup where a value may need to be changed significantly.

Finally, use the “SAVE” key to save entered values. After you are satisfied with all entries and adjustments, press the “SAVE” key to transfer all new set point values into EEPROM memory. The EEPROM retains all set points when power is removed from the control.

NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

The control ignores all other keys on the Hand Held Programmer.

Menu (Set Point) Descriptions

Menu 1 — Dynamics Menu
Menu 2 — Alternate Dynamics Menu

Dynamic adjustments are settings that affect the stability and transient performance of the engine. There are two sets of dynamics provided. The set being used is selected by the Alternate Dynamics Contact input. The following descriptions of each menu item apply to either set. Also see Figures 3-2, 3-3, and 3-4.

1. Gain determines how fast the control responds to an error in engine speed from the speed-reference setting. The gain is set to provide stable control of the engine at light or unloaded conditions.

2. Stability compensates for the lag time of the engine. It adjusts the time required for the control to return the speed to zero error after a disturbance. Stability is adjusted to prevent slow hunting and to minimize speed overshoot after a load disturbance.

3. Compensation compensates for the actuator time constant.

4. Gain Ratio is the ratio of the Gain setting at steady state to the Gain setting during transient conditions. The Gain Ratio operates in conjunction with the Window Width and Gain adjustments by multiplying the Gain set point by the Gain Ratio when the speed error is greater than the Window Width. This makes the control dynamics fast enough to minimize engine-speed overshoot on start-up and to reduce the magnitude of speed error when loads are changing. This allows a lower gain at steady state for better stability and reduced steady-state actuator linkage movement.

5. Window Width is the magnitude (in rpm) of a speed error at which the control automatically switches to fast response. The control does not use the absolute value of speed error, but “anticipated” speed error to make this switch. This method provides for quick switching to the high gain value when an offspeed occurs and early switching to the low gain value when recovering from the speed transient. This provides smoother switching than if the absolute speed error was used for the window.

6. Gain Breakpoint sets the percent output above which the Gain Slope becomes effective. It should usually be set just above the minimum load output.

7. Gain Slope changes Gain as a function of actuator output. Since actuator output is proportional to engine load, this makes gain a function of engine load. Gain Slope operates in conjunction with the Gain Breakpoint adjustment to increase (or decrease) gain when percent actuator output is greater than the breakpoint. This compensates for systems having high (or low) gain at low load levels. This allows the Gain setting to be lower at light or no load for engine stability, yet provide good control performance under loaded conditions.

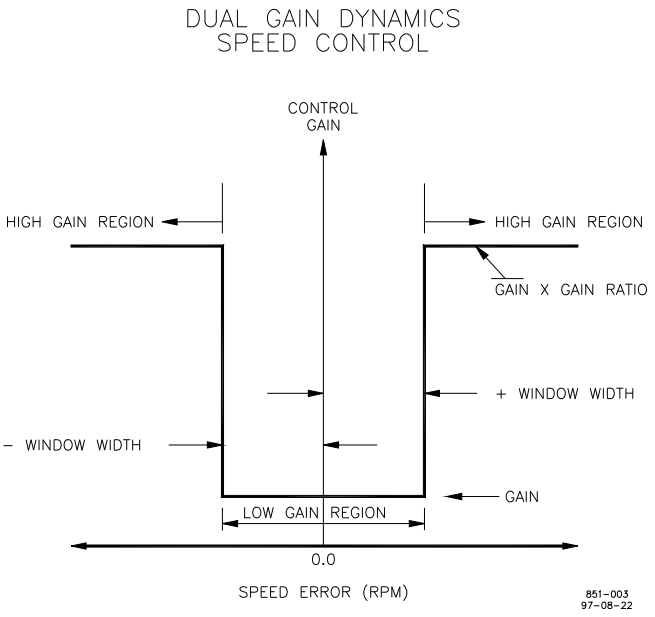

Figure 3-2. Control Gain as a Function of Speed Error

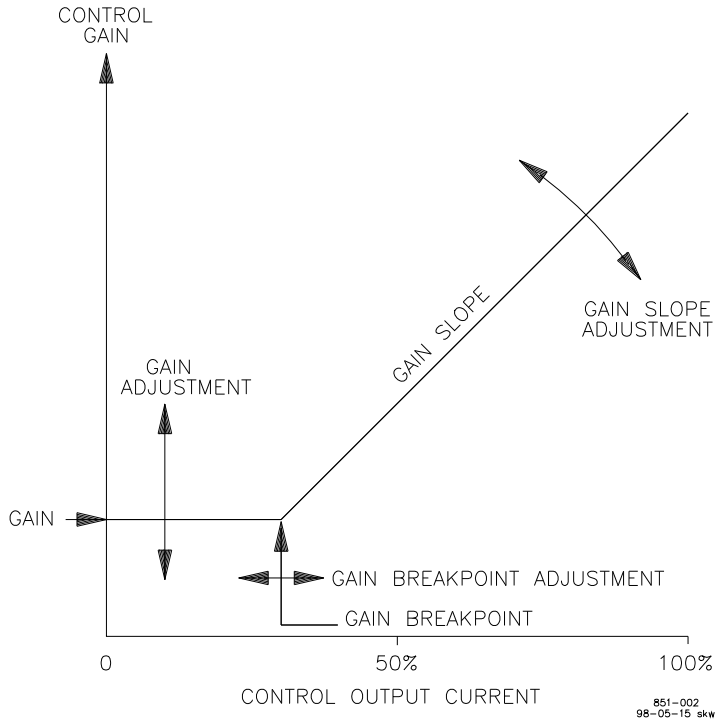

Figure 3-3. Control Gain as a Function of Control Output

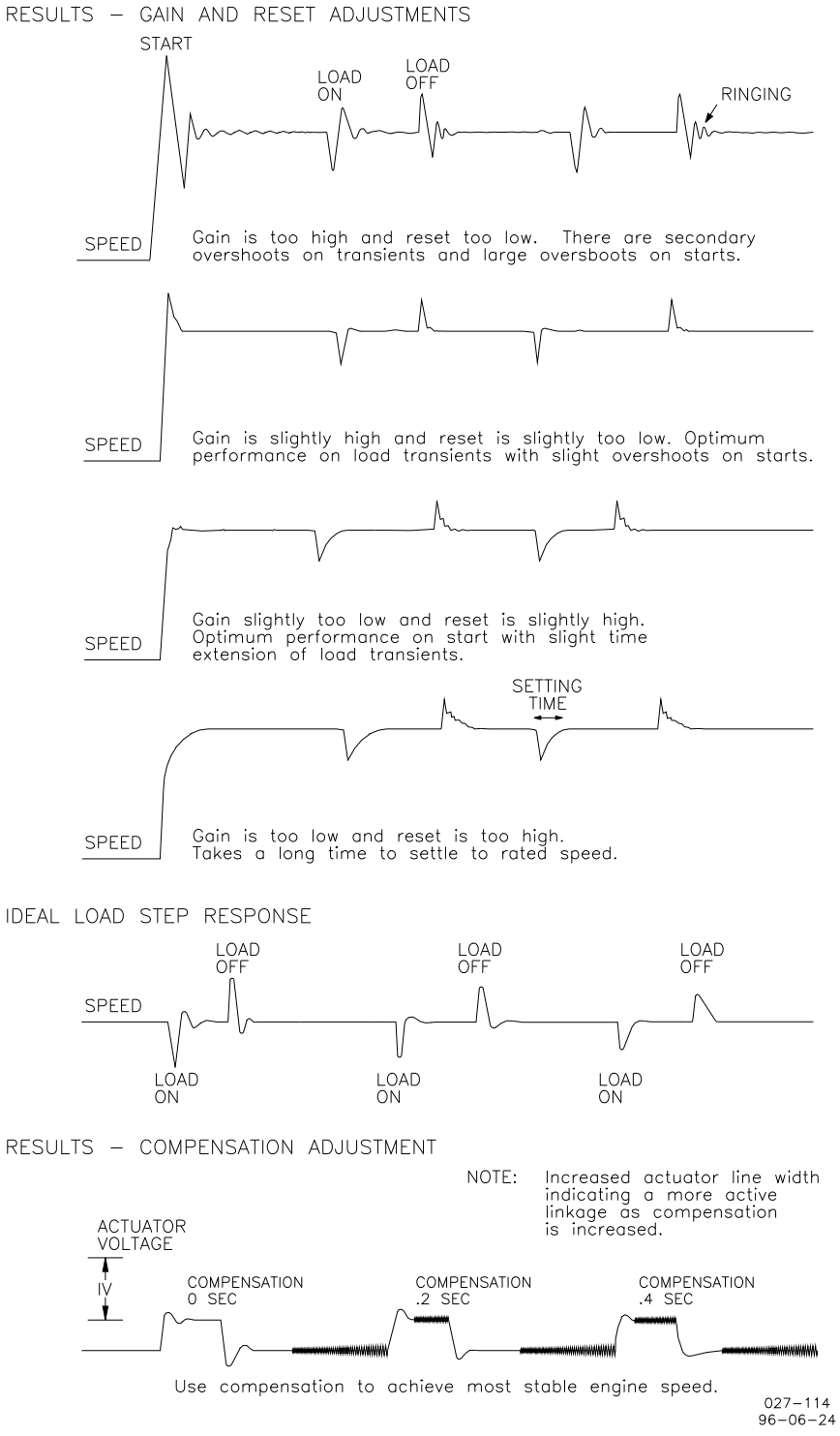

Figure 3-4. Typical Transient Response Curves

Menu 3 — Speed Setting Menu

Speed adjustments are the settings that affect the speed reference. Descriptions of each menu item follow.

1. Raise Limit is the maximum speed reference setting. It is used to limit the Raise Speed command and Remote Reference to a maximum. It normally is set at the maximum rated engine speed.

2. Lower Limit is the minimum speed reference setting. It is used to limit the Lower Speed command and Remote Reference. It normally is set at the minimum operating speed of the engine.

3. Idle Speed sets the speed at which the engine is operated at start-up. It sometimes is used during cool down.

4. Accel Time is the time required for the control to ramp the engine speed from idle speed to rated speed. The ramp is started whenever the Idle/Rated switch is closed.

5. Decel Time is the time required for the control to ramp the engine speed from rated speed to idle speed. The ramp is started whenever the Idle/Rated switch is opened.

IMPORTANT

Actual engine deceleration may be slower than set by the Decel Time set point. This occurs when the Decel Time set point is faster than system inertias will allow the engine to come down in speed. This condition is indicated by the control actuator output going to the minimum fuel position. See Idle Droop below.

6. Raise Rate is the rate at which the speed reference is ramped when using the Raise command as well as when the Remote Speed Setting input is changed in the increase direction. A step change on the remote input does not cause an immediate change in the reference, which is ramped to the new setting at the Raise Rate.

7. Lower Rate is the rate at which the speed reference is ramped when using the Lower Speed command as well as when the Remote Speed Setting input is changed in the decrease direction. A step change on the remote input does not cause an immediate change in the reference, which is ramped to the new setting at the Lower Rate.

8. 20ma Remote Ref(erence) is the engine speed desired when 20 mA is applied to the Remote Speed Reference input.

9. 4ma Remote Ref(erence) is the engine speed desired when 4 mA is applied to the Remote Speed Reference input.

10. 20ma Tach RPM is the engine speed when the aux output is 20 mA (see Menu 1, Aux Output Configuration).

11. 4ma Tach RPM is the engine speed when the aux output is 4 mA (see Menu 1, Aux Output Configuration).

12. Droop is based on the control output, which is proportional to engine load. The droop obtained is dependent on linkage adjustment and stroke. For example, 5% droop gives a real droop of 2.5% if the control output changes 50% from no load to full load.

13. Idle Breakpoint is normally set equal to the control output obtained when the engine is unloaded and at low idle. When the output of the control drops below this setting or goes to minimum fuel during rapid engine deceleration, Idle Droop, described above, will raise the speed reference. This brings the engine back under control sooner and reduces speed undershoot. Speed undershoot may occur because the time required for the control to return to the new fuel setting takes time dependent on control dynamics and linkage adjustment.

14. Idle Droop is based on the control output current when it drops below the Idle Breakpoint setting (see Idle Breakpoint below). Dependencies on linkage make the Idle Droop percentage relative so large droop settings may be required to achieve the desired results.

15. Torsional Filter is the integrator gain for the adaptive torsional filter. Range is from 0.0 to 1.0. A value of 0.0 prevents adaptation to torsionals and disables the torsional filtering. A value of 1.0 results in immediate adaptation, but also causes adaptation to noise, speed transients, etc. Use smaller values to reduce noise in the control outputs. Use higher values for faster filter adaptation during starting or when changing speed/load. We recommend an initial value of 0.2 to 0.3.

Menu 4 — Fuel Limiters and Control Output Menu

Fuel limiters limit the actuator output current from the control. Descriptions of each menu item follow.

1. Max Fuel Limit sets the maximum percent actuator output current when rated speed is selected. Maximum (100%) is based on 200 mA (100% is based on 20 mA for the 20 mA output version of the 701A). The limit is usually set just above the output at full load. The percent output is displayed on Menu 7.

2. Start Fuel Limit sets the maximum percent actuator output current when at the start speed specified below. The limit is usually set at the fuel level required to start the engine.

IMPORTANT

Maximum and Start Fuel Limiters are also effective when the Local/Remote mode is in Remote. If only the Local/Remote reference is used, the Idle/Rated switch must still be used to select the appropriate fuel limit.

3. Start Speed is the engine speed at which ignition usually occurs during engine start-up. When an engine speed is below the Start Speed setting, the maximum percent actuator current is determined by the Start Fuel Limit. When the engine accelerates between Start Speed and Idle Speed, the maximum current is ramped to the Idle Fuel Limit in proportion to speed.

4. Idle Fuel Limit sets the maximum percent actuator output current when the engine is operated at idle. During engine start-up, the maximum fuel is increased (or decreased if Idle Fuel Limit is less than the Start Fuel Limit) from the Start Fuel Limit to the Idle Fuel Limit in proportion to the engine speed. For initial start, set this at 100% to deactivate.

The Idle Fuel Limit allows the fuel limit to ramp from the Start Fuel Limit, to the Idle Fuel Limit, to the Max Fuel Limit, to provide smoother transitions and less overfueling. Their use is optional.

5. Torque Limit BP (breakpoint) is the engine speed at which the slope of the torque limiter output changes. The Torque Limit Breakpoint must be set between the Raise and Lower Limits described under Menu B above.

6. Min Torque Limit is the percent actuator output current allowed when the engine speed is at or below the Lower Limit speed setting (Menu B Lower Limit set point above). The torque limiter interpolates between Minimum Torque Limit and Breakpoint Torque Limit when engine speed is between these two settings.

7. BP (breakpoint) Torque Limit is the percent actuator output current at the engine speed set by the Torque Limit Breakpoint described above.

8. Max Torque Limit is the maximum percent actuator output current when the engine speed is at the Raise Limit speed setting. The torque limiter interpolates between the Breakpoint Torque Limit and Maximum Torque Limit when engine speed is between these two settings.

   Figure 3-5 illustrates the breakpoint and these adjustments.

9. 20ma Aux Actuator Output is the actuator percent corresponding to full scale on the user-supplied actuator position meter (20 mA output from the control; see Menu 1, Aux Output Configuration).

10. 4ma Aux Actuator Output is the actuator percent when corresponding to minimum scale on the user-supplied actuator position meter (4 mA output from the control; see Menu 1, Aux Output Configuration).

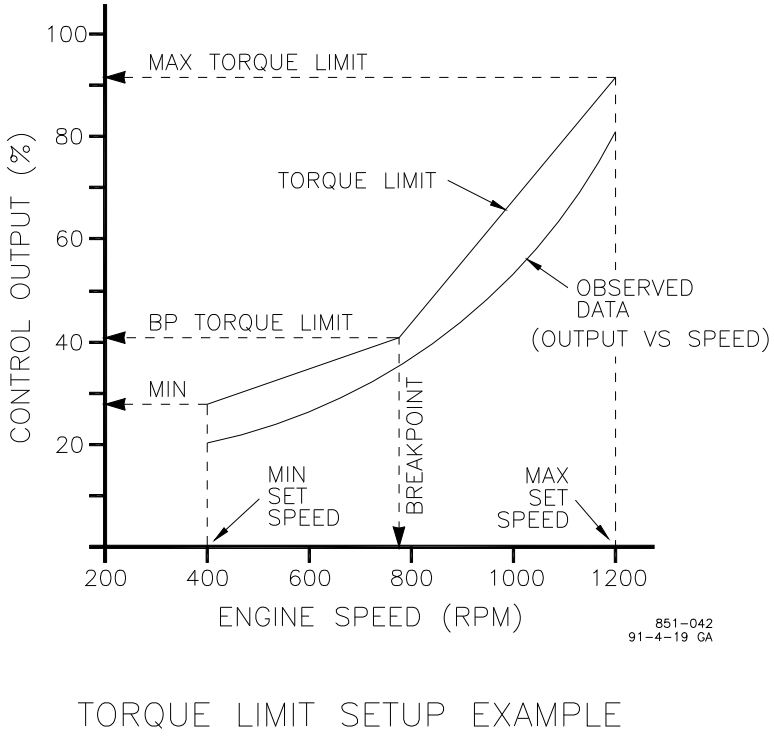

Figure 3-5. Torque Limit Setup Example

Menu 5 — Configuration Menu

1. Configuration Key is a code which you must enter before you can change any of the set points on the configuration menu. This helps prevent accidental modification of the set points. The code is factory set to “49”. Use the “Turtle Up” and “Turtle Down” keys to select the code. Engine speed must be 0 rpm, and the Minimum Fuel (Run/Stop) contact must be open to enter this menu. Whenever the Minimum Fuel (Run/Stop) input is changed, the code will be reset to “0”.

IMPORTANT

The Minimum Fuel (Run/Stop) contact must be open, engine speed must be 0, and the Configuration Key must be set to “49” to change any of the set points on the Configuration menu. Failure to meet any of these conditions will result in an error message being displayed on the Hand Held Programmer.

2. Rated Speed (synchronous speed) sets the normal operating speed of the engine. It should be set at the speed at which the engine is operated at full load.

3. Num Gear Teeth is the number of teeth or holes in the gear or flywheel the speed sensing device is on. If the gear is running at camshaft speed (one-half engine speed) then you must enter one-half the number of teeth on the gear. The control requires the number of teeth per engine revolution.

4. Num Samples specifies the number of speed samples the control will take during each engine revolution. Range is integer values from 1 to 30, with the maximum limited in software to provide a minimum sample interval of 10 milliseconds at rated speed.

   For example: An engine with a rated speed of 500 rpm has a one-revolution rotation time of 120 milliseconds (60 sec/500 rpm). For a 10-millisecond sample interval, the control could sample at most 12 times. So Num Samples would have to be set to 12 or less. A Num Samples setting of 6 would give a 20 millisecond sample time in this example.

IMPORTANT

Make sure you set Rated Speed BEFORE you set Num Samples. And if you change Rated Speed, be sure to recheck Num Samples, since a higher Rated Speed could automatically reduce the Num Samples setting.

   It may be simplest to pick a value for Num Samples that is an integral of the number of cylinders. That is, if you engine has six cylinders, use Num Samples = 3, 6, 12, or 24. If your engine has nine cylinders, use Num Samples = 3, 9, or 18.

5. Engine Type specifies whether the control uses an algorithm for a 2-stroke engine or for a 4-stroke engine. The 2-stroke/4-stroke information is used by the proprietary firing torsional filtering algorithm.

6. Actuator Sense sets the direction of the control actuator output to increase fuel. Forward-acting actuators require increased current to increase fuel. Reverse-acting actuators require decreased current to increase fuel (reverse-acting actuators should always incorporate a mechanical ballhead backup governor, such as the Woodward EGB).

7. Dynamics Map selects the mapping algorithm used to map dynamics as a function of engine speed. Figure 3-6 illustrates how dynamics vary as a function of engine speed for each map. The 701A control provides two dynamics maps, Linear and Non-Linear.

   The Linear map is normally suitable for all medium- to high-speed engines. With the Linear map, Gain is proportional to engine speed and Stability and Compensation are held constant. The Gain set point may be adjusted at any engine speed, but the value is normalized to the rated speed reference. For example, if Gain is set to 0.1 and current engine speed is 50 percent of the maximum, then the actual gain used in the control algorithm will be 0.05, or 50 percent of the set point value. If engine speed is at rated, actual gain will be 100 percent of the set point value.

   The Non-Linear map provides additional Stability and Compensation inversely proportional to engine speed for low- to medium-speed engines. Gain for the Non-Linear map is proportional to the square of engine speed. For example, at 50 percent of maximum speed, the actual gain will be 25 percent of the set point value and Stability and Compensation values will be two times greater than at maximum speed.

   The final decision on which map to use depends on engine performance obtained throughout the operating speed and load range. After tuning the control for desired performance under rated speed and load conditions, performance at low speed and light loads should be evaluated. If low frequency speed oscillation occurs at low speeds using the Linear map, the Non-Linear map will provide additional Stability. If performance is poor at low speed using the Non-Linear map, the Linear map will provide higher performance. Select the map that provides the best overall performance for all operating conditions.

8. Remote Fault specifies whether the Remote Speed Reference will lock-in-last (stay at its current value) or ramp the Remote Speed Reference to the value of the 4mA Remote Reference set point on Menu 4 whenever a Remote Input signal fault is detected (see Chapter 5 for detailed operation).

9. Speed Sense specifies whether the 701A control uses its adaptive or non-adaptive speed sensing algorithm.

   The adaptive algorithm learns the torsionals in the engine system, then uses the Torsional Filter setting in Menu 3 to determine the amount the 701A control responds to the torsionals.

   The non-adaptive algorithm digitally filters out the torsionals in a manner like the 701 control, but has an added feature which allows selecting the number of samples. When the non-adaptive algorithm is used, the Torsional Filter setting on Menu 3 has no effect.

   The adaptive algorithm is designed to give a fast response time but is sensitive to engine misfires. The non-adaptive algorithm has a slower response time but is not sensitive to engine misfires. If the type of speed-sensing algorithm is changed, the gain settings will need to be readjusted due to the response time of the speed-sensing algorithm.

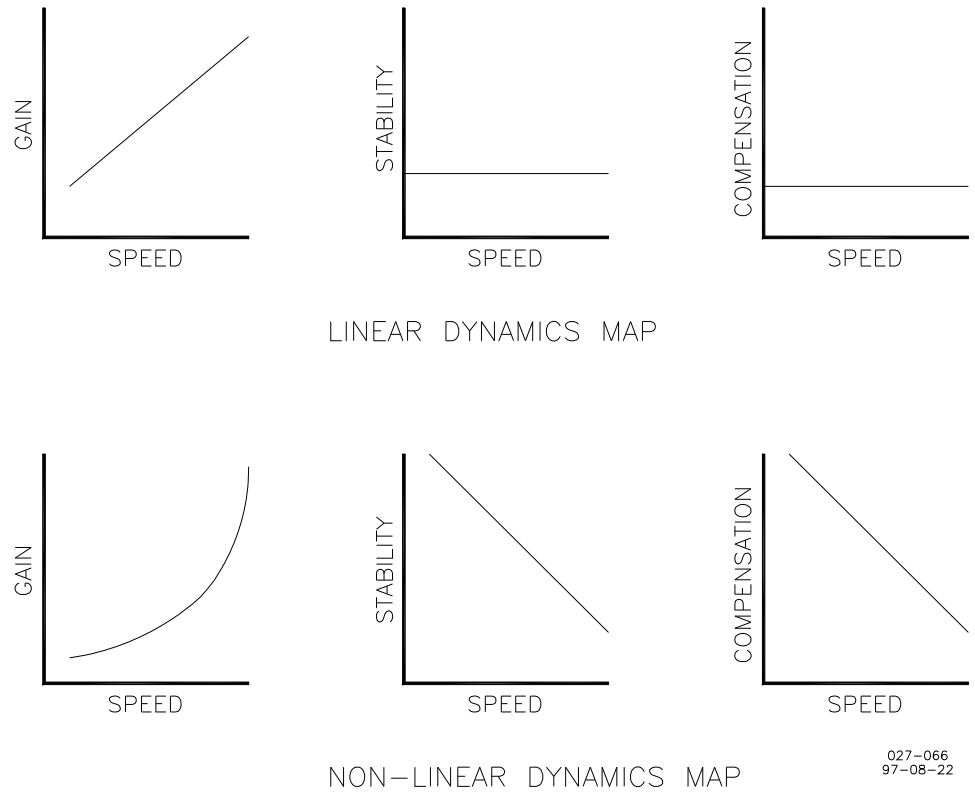

Figure 3-6. Dynamics Map Curves

The 701A Speed Sense can be set up to respond like the 701 speed sense by selecting the non-adaptive algorithm and setting the Number of Samples to 4.

10. Aux Output selects either actuator percent readout (Menu 4) or tachometer readout (Menu 3) for the aux output. Use the up and down arrow keys to select the desired display.

Menu 6 — Calibration Menu

Input and output values are displayed once when each item is selected.

IMPORTANT

Woodward has done a factory calibration on the control prior to shipment, and it should not normally require field adjustment. See the Control Test and Calibration section in Chapter 6 for proper adjustment procedure.

1. Calibration Key is a code which you must enter before you can change any of the set points on the calibration menu. This helps prevent accidental modification of the set points. The code is factory set to “49”. Use the “Turtle Up” and “Turtle Down” keys to select the code. Whenever the Minimum Fuel (Run/Stop) input is changed, the code will be reset to “0”.

IMPORTANT

The Minimum Fuel (Run/Stop) contact must be open, engine speed must be 0, and the Calibration Key must be set to "49" to change any of the set points on the Calibration menu. Failure to meet any of these conditions will result in an error message being displayed on the Hand Held Programmer.

2. Remote In(put) Cal(ibration) calibrates the 4-20 mA Remote Speed Setting input by adjusting the value of the input current as seen by the control software. This calibration is done by Woodward prior to shipment and should not normally require field adjustment. See the Control Test and Calibration section in Chapter 6 for proper adjustment procedure.

3. Aux Input Cal(ibration) calibrates the ±2.5 Vdc Aux input by adjusting the value of the input voltage as seen by the control software. This calibration is done by Woodward prior to shipment and should not normally require field adjustment. See the Control Test and Calibration section in Chapter 6 for proper adjustment procedure.

4. Aux Output Cal(ibration) calibrates the 4-20 mA Aux output by adjusting the value of the aux output current as seen by the control software. This calibration is done by Woodward prior to shipment and should not normally require field adjustment. See the Control Test and Calibration section in Chapter 6 for proper adjustment procedure.

Menu 7 — Display Menu 1

Input and output values are displayed once when each item is selected. Descriptions of each menu item follow.

1. Engine Speed displays the current engine speed in rpm.

2. Speed Reference displays the current speed reference in rpm. Note that this may not be the speed the engine is currently running at due to the effect of idle droop, fuel limiters, etc.

3. Actuator Output displays the current percent of output. Maximum (100%) is 200 mA (20 mA for the 20 mA version, 0 mA for reverse-acting). This is useful for setup of the control fuel limiters, torque limiter, idle droop, and gain breakpoint settings.

4. Aux Output displays the milliamps on the Aux Output. This is useful for testing and system calibration.

5. Remote Input displays the milliamps on the Remote Speed Setting Input. This is useful for testing and system calibration.

6. Aux Input displays the voltage on the Aux Input.

7. Control Mode displays the current Control Mode status such as stopped, speed ramp, etc. This is useful for testing and system troubleshooting.

Menu 9 — Display Menu 2

1. Run/Stop Contact displays the status of discrete input A, terminal 9. Closed indicates 24 Vdc is applied to the input selecting the run position. Open selects minimum fuel or the stop position.

2. Idle / Rated displays the status of discrete input B, terminal 10. Closed indicates 24 Vdc is applied to the input selecting rated speed and the maximum fuel limit and the torque limit. Open indicates idle and the start fuel limit are selected.

3. Lower Speed displays the status of discrete input C, terminal 11. Closed indicates 24 Vdc is applied to the input selecting lower speed (or remote speed setting if the Raise switch is also closed).

4. Raise Speed displays the status of discrete input D, terminal 12. Closed indicates 24 Vdc is applied to the input selecting raise speed (or remote speed setting if the Lower switch is also closed).

5. Dynamics Switch displays the status of discrete input E, terminal 13. Closed indicates 24 Vdc is applied to the input selecting the alternate dynamics (dynamics 2).

6. Failsafe Override displays the status of discrete input F, terminal 14. Closed indicates 24 Vdc is applied to the input selecting to override the function of the failed speed detection which provides for moving fuel to minimum position when no speed signal is detected by the control.

Menu 0 — Diagnostics Menu

1. Watchdog Status displays the status of the control CPU. The normal status displayed is CPU OK. If a CPU fault occurs, the CPU OK indicator on the front of the control will turn off, the Actuator Output and Aux Output will decrease to minimum output, and the Watchdog Status will display TIME OUT. To reset the watchdog, turn off power to the control for a minimum of 10 seconds.

2. Diagnostics Result shows the result of the power up diagnostics done on the microprocessor, data, and program memory. A successful test gives a result of 49. Report any other result to Woodward when returning the control for repair.

3. ROM Check Sum is used by Woodward during factory tests. An incorrect result will give a Self Test Result error also.

At this time, we recommend saving this setup by pressing the SAVE key on the Hand Held Programmer. The programmer will display the message “Set Points Saved.” Be sure to select a menu prior to continuing.

NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

Chapter 4.
Initial Adjustments

Introduction

This chapter contains information on control calibration. It includes initial prestart-up and start-up settings and adjustments.

WARNING

An improperly calibrated control could cause an engine overspeed or other damage to the engine. To prevent possible serious injury from an overspeeding engine, read this entire procedure before starting the engine.

Start-up Adjustments

1. Complete the installation checkout procedure in Chapter 2 and the prestart menu settings in Chapter 3.

2. Close the Run contact. Open the Failed Speed Override contact. Be sure the Idle/Rated contact is in Idle (Open). Apply power to the control.

3. Check the speed sensor.

   Minimum voltage required from the speed sensor to operate the control is 1.0 Vrms, measured at cranking speed or the lowest controlling speed. For this test, measure the voltage while cranking, with the speed sensor connected to the control. Before cranking, be sure to prevent the engine from starting. At 5% of rated speed and 1.0 Vrms, the failed speed sensing circuit function is cleared.

WARNING

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

4. Start the engine.

   If there is insufficient fuel to start the engine, increase the Start Fuel Limit (Menu 4). (The control will reduce fuel as required when the speed setting is reached. It requires extra fuel to accelerate the engine to idle speed.) It may take a few starts to determine the final setting of the Start Fuel Limit. If the start time is excessive, increase the Start Fuel Limit. If the start time is too fast or flooding is occurring, decrease the Start Fuel Limit. We recommend trying both hot and cold starts to determine a final setting.

5. Adjust for stable operation.

   If the engine is hunting at a rapid rate, slowly decrease the Gain (Menu 1/2) until performance is stable. If the engine is hunting at a slow rate, increase the Stability time. If increasing the Stability time does not stabilize the engine, it also may be necessary to slowly decrease the Gain OR to slowly decrease the Gain and increase the Compensation.

This completes the Start-up adjustments. We recommend saving the settings at this time by pressing the SAVE key on the Hand Held Programmer.

Dynamic Adjustments

The objective of the dynamic adjustments is to obtain the optimum, stable engine speed response from minimum load to full load and speed operating conditions. All adjustments apply to both sets of dynamics, 1 and 2. Use the set point with "1" following when the Alternate Dynamics contact is open and "2" when closed.

1. No-Load Adjustments

   Do this adjustment without load applied.

   Slowly increase the Gain set point until the engine becomes slightly unstable, then reduce the Gain as necessary to stabilize the engine.

   After obtaining acceptable performance at no load, record the Actuator Output as read on Menu 7. Set the Gain Breakpoint (Menu 1/2) to this reading.

2. Minimum Load Adjustment

   Do this adjustment at the minimum speed and load conditions at which the engine is operated. Be sure to select Rated Speed to switch to the maximum-fuel limit. Speed may be set either with the Raise and Lower commands in local or with a 4 to 20 mA speed reference in remote.

   Observe the movement of the actuator. If the activity of the actuator is excessive, reduce the Gain set point slightly to get the actuator movement to an acceptable level.

   If there is a slow periodic cycling of the engine speed above and below the speed setting, there are two possible causes:

   Gain is too high and Stability is too low. Reduce the gain by 50% (i.e., if the gain was 0.02, reduce it to 0.01) and increase Stability slightly. Observe the movement of the actuator. Continue to increase Stability until the movement is acceptable but not excessive. A final value of Stability should be between 1.0 and 2.0 for most large engines. If the Stability value exceeds 2.0, but this procedure continues to improve performance, increase the Compensation set point 50% and repeat the procedure.

   Gain is too low. If the preceding procedure does not improve the slow periodic cycling of the engine speed, the control may be limiting cycling through the low gain control region set by the Window Width set point. Increase the Gain set point to minimize the cycling. If actuator movement becomes excessive, reduce the Compensation set point until movement is acceptable. In some cases, Compensation may be reduced to zero and only the Gain and Stability adjustments used. This should be done only if necessary to eliminate excessive actuator response to misfiring or other periodic disturbances. Reduce the Window Width set point until the limit cycle amplitude is acceptable without excessive rapid actuator movement.

3. Full Load Adjustment

   Do these adjustments at the speed and load ratings at which the engine is most often operated.

   If operation in this range is satisfactory, no further dynamic adjustments are necessary. If during changes in speed or load, excessive speed errors occur, increase the Gain Slope adjustment until engine performance is satisfactory. If excessive actuator movement again occurs, do procedure 4, then repeat procedure 3. If the settling time after a speed or load change is too long, reduce the Stability set point slightly and increase the Gain slightly. If slow-speed hunting occurs after a load or speed change but decreases or stops in time, increase the Stability set point slightly and reduce the Gain set point. See Figure 3-4.

⚠WARNING

The use of negative gain slope should be considered carefully. Low gain at high fuel levels will result in poor load rejection response or possible overspeed. To prevent possible serious injury from an overspeeding engine, the Max Fuel Limit, Menu 4, must be set near the full load output current demand to prevent excessive integrator windup and a subsequent low gain condition.

4. When speed and load changes occur, the control should switch automatically to high gain to reduce the amplitude of the offspeeds. Reduce (or increase) the Window Width set point to just greater than the magnitude of acceptable speed error. A value of Gain ratio too high will cause the control to hunt through the low-gain region. This normally will occur only if the Window Width is too low. If necessary to decrease the Window Width to control limit cycling (identified by the engine speed slowly cycling from below to above the speed setting by the amount of Window Width), the Gain Ratio may be reduced for more stable operation.

5. Verify that performance at all speed and load conditions is satisfactory and repeat the above procedures if necessary.

6. While operating at minimum speed and load, record the Actuator Output on Menu 7. Select the Idle Breakpoint on Menu 3. Set at the recorded value.

7. While operating at full load, record the Actuator Output on Menu 7. Select the Max Fuel Limit set point on Menu 4. Set at approximately 10% over the full load output if desired, otherwise leave at 100%.

8. If the Torque Limiter is being used, record the Actuator Output and Engine Speed (Menu 7) while operating the engine under various speed and load conditions. These values will be used to determine the initial Torque Limit set points below.

9. If alternate dynamics are to be used, repeat the above procedures with the Alternate Dynamics contact closed and the engine operating conditions selected for which the dynamics are required. Use the adjustments with a “2” following them.

We recommend you check the operation from both hot and cold starts to obtain the optimum stability under all conditions.

Speed Adjustments

Local Speed References (Idle, Rated, Raise and Lower) should not require further adjustment as they are precisely determined. The Remote Speed Input and the Aux Output, however, involve analog circuits and may require adjustment.

1. 4 to 20 mA Remote Speed Setting Input

   Apply 4 mA to the Remote Speed Setting Input. Be sure Remote is selected. Observe the operating speed of the engine as displayed on Menu 7. If the engine rpm is lower or higher than desired, increase or decrease the 4ma Remote Ref set point on Menu 3 to obtain the correct speed. There may be a small difference between the set point and actual speed which compensates for the inaccuracies in the analog circuits.

   Now apply 20 mA to the Remote Speed Setting Input. Wait until the ramp stops. Increase or decrease the 20 mA Remote Reference set point to obtain the tach speed desired.

   Repeat the above steps until the speeds at 4 mA and 20 mA are within your required range.

2. 4 to 20 mA Tachometer Output

   Set engine speed to the speed desired for 4 mA output. If this is not possible, skip this step or use a signal generator into the speed input with the correct frequency corresponding to the desired rpm. Trim the 4 mA Tach rpm set point for 4 mA set point output.

   Set engine speed to the speed desired for 20 mA output. Trim the 20 mA Tach rpm set point for 20 mA set point output.

   Repeat the above steps until the speeds at 4 mA and 20 mA are within your required range.

3. Droop adjustment

   If the control is operated isochronously or if droop is set by an external load sensor, set Droop to 0%. If droop operation is required, set Rated Speed to achieve the desired high idle speed. Increase load to rated, set droop to obtain the desired rated speed.

IMPORTANT **The percent Droop is only a guide. Since droop is a function of actuator current, droop is affected by linkage, fuel system, etc.**

4. Idle Droop adjustment.

   If engine deceleration remains under control of the Decel Ramp or the Lower Ramp, these adjustments may not need to be done.

Set the Idle Breakpoint to the output percent obtained previously at no load. Set engine speed to at least 25 percent above the no-load speed. Then use the Lower Speed input to call for minimum engine speed. Observe undershoot of engine speed below the no-load speed. If excessive undershoot is observed, increase the Idle Droop set point by 10% and repeat the above procedure. Proper adjustment is obtained when undershoot is within desired specification.

IMPORTANT

The Low Idle Droop causes an increase in the speed reference when actuator current is below the Idle Breakpoint. The amount the reference is increased is dependent on linkage adjustment, reflected in the Idle Breakpoint setting, and Low Idle Droop set point. Large values of droop may be required to achieve the desired performance when small Idle Breakpoint settings are obtained. For best performance in controlling speed undershoot, the output percent at idle should be less than 25 percent. If a value greater than this is obtained, the linkage adjustment should be modified to reduce the control output to below 25 percent at idle. After adjustment of the linkage, complete fuel cutoff should be verified to occur prior to reaching the minimum stop on the actuator.

Torque Limiter Adjustment

If the torque limiter is not being used, leave the set points at the 100% values set during prestart adjustment.

The values of the Actuator Output and Engine Speed (Menu 7) obtained above provide the guide to adjustment of the torque limiter set points. As a starting point, plot actuator output percent versus engine rpm as shown in Figure 3-5. Plot a best fit two-slope line 10% of the output range (maximum - minimum output values) above the curve obtained. Set the Breakpoint Torque Limit to the engine speed corresponding to the breakpoint in the two lines. Set the Minimum Torque Limit, Breakpoint Torque Limit, and the Maximum Torque Limit at the output values obtained at their respective speeds. Test engine performance through the speed and load range for satisfactory performance. If the engine accelerates too slow, or becomes overloaded for the fuel allowed, the set point values must be set higher. If acceleration is too fast or excessive smoke occurs, the set point values should be set closer to the observed data.

Aux Actuator Output Adjustment

If an actuator position (percent) meter is used instead of a tachometer, select Aux Output in Menu 5 and set to Actuator Percent. Then set Menu 4 (20ma Aux Actuator and 4ma Aux Actuator) for the desired meter range. The 4ma Aux Actuator output is the desired actuator position at minimum scale on the meter (for example, no load or minimum actuator). The 20ma Aux Actuator output is the desired actuator position at full scale on the meter (for example, full load or maximum actuator).

Select 20ma Aux Actuator on Menu 4. Adjust to the desired actuator percentage for 20 mA output (full scale on the meter).

Select 4ma Aux Actuator on Menu 4. Adjust to the desired actuator percentage for 4 mA output (minimum scale on the meter).

For Aux Output configuration and calibration, see the calibration procedure in Chapter 6.

IMPORTANT

If 4ma Aux Actuator and 20ma Aux Actuator are the same value, the Aux Output will be 0 mA.

Conclusion of Setup Procedures

This completes the adjustment chapter. Save the set points by pressing the SAVE key on the Hand Held Programmer. Run through all the set points and record them for future reference. This can be useful if a replacement control is necessary or for start-up of another similar unit. Power down the control for about 10 seconds. Restore power and verify that all set points are as recorded.

NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

Disconnect the Hand Held Programmer from the control. Close the cover over J1 and retighten the retaining screw.

Chapter 5.
Description of Operation

General

This section provides an overview of the features and operation of the 701A Digital Speed Control. Figure 1-4 shows the control block diagram and Figure 1-3 is the plant wiring diagram for reference in the following descriptions.

The 701A Digital Speed Control uses a 16-bit microprocessor for all control functions, such as computing engine speed, doing the control algorithm calculations, speed ramps, etc. All control adjustments are made with a hand-held terminal/display that communicates with the control via a serial port. The terminal/display is disconnected from the control when not in service to provide security against tampering.

The speed sensor contains a special tracking filter designed for reciprocating engines, which minimizes the effects of engine torsionals or irregularities in the gear used for sensing speed. This provides exceptionally smooth steady-state control and allows the control dynamics to be matched to the engine rather than detuned to compensate for speed torsionals. The speed signal is usually provided by a magnetic pickup or proximity probe supplying 1 to 60 Vrms to the control.

The control features a switching power supply with increased spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are optically isolated and capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common mode noise rejection. This protects the control from spurious interference and noise that can cause speed and load shifts.

An auxiliary analog input is provided to interface with Woodward Power Sensors to provide isochronous load sharing or droop operation.

The control also provides a 4 to 20 mA tachometer output or a 4 to 20 mA actuator position output for an analog meter or as input to a computer. The offset and span are adjustable for range.

Control Dynamics

The control algorithms used in the 701A control are designed specifically for reciprocating engine applications. Control dynamics are varied automatically as functions of both speed and load to provide better performance over the operating range of the engine.

The 701A control provides two mappings of control dynamics as a function of speed (see the following sections for more information on maps and tuning parameters). The control automatically maps gain proportional to engine speed. This provides higher gain at normal operating speeds and lower gain at low speeds. This provides a better match with engine control requirements than a constant gain control. A second optional dynamics mapping provides additional stability as speed is decreased. This feature is useful particularly on large, low-speed engines where dead time between cylinder firings becomes an important factor in performance.

To provide better transient performance, the control can be operated automatically with two gain settings depending on engine speed error (speed error is the difference between the speed setting and the actual engine speed). During steady-state operation with a constant load, the control uses the base gain setting. This gain is adjusted by the user to a value to prevent the control from responding to minor fluctuations in engine speed, a common problem with gas-fueled, spark-ignited engines. This feature eliminates potentially damaging jiggle of the actuator and fuel system. The control automatically increases gain by an adjustable ratio when a speed error exceeding an adjustable window occurs. Operation with base gain is restored once the control senses the return to steady-state speed.

The control can also compensate for nonlinear fuel systems and changes in engine dynamics with load. The control dynamics are mapped as a function of actuator current (actuator current is proportional to engine load). This provides optimal dynamics and smooth steady-state operation for all conditions from no load to full engine load.

The control also provides two complete sets of dynamic adjustments that are externally selectable. The two sets of dynamics are provided for use where engine operating conditions change, such as in systems with clutched-in loads, dual fuel sources, and electrical power generation where the unit may be operated stand alone or paralleled with an infinite bus.

Fuel Limiters

The 701A Digital Speed Control provides a Start Fuel Limiter to limit overfueling or flooding during start-up. The limiter is set to provide the desired maximum rack position during starts. The control will reduce the fuel when the speed set point is reached as required to control engine speed, but will not exceed the start limit.

A Load Limit set point is provided to limit the maximum output current of the control during normal engine operating conditions.

A two-slope torque limiter is provided for mechanical drive applications. The torque limiter provides a maximum rack position determined by current engine speed to limit overfueling and subsequent smoke emission during engine acceleration. The torque limiter is low signal selected with the load limit.

Speed Reference and Ramps

The 701A control provides local control of the speed reference with discrete inputs to issue raise and lower speed commands. For remote speed setting, the control provides a 4 to 20 mA/1 to 5 Vdc input which is used for the speed reference. This section describes the operation of each of the speed reference and ramp functions and their relation to each other. Read this section carefully to be sure your switchgear sequencing provides the proper operating modes.

The control provides Idle, Lower Limit, Rated, and Raise Limit set points along with Accel and Decel Time and Raise and Lower Rates for local operation. Accel Time determines the time required for the engine to ramp from idle (low idle) to rated (fast idle) speed. Decel Time determines the time required for the engine to ramp from rated speed to idle speed. Raise and Lower Rates determine how fast speed is increased or decreased by the Raise and Lower command inputs.

The Idle Speed set point is provided for engine start-up or cool down speed. Idle speed may be set equal to or less than the rated speed set point. Idle is independent of the Lower Limit set point and may be set to a lower speed. When Idle is selected (Idle/Rated switch in Idle position with contacts open), Remote, Raise, and Lower inputs are all disabled. Idle speed cannot be changed except through adjustment of the Idle Speed set point. In idle, the start fuel limit is in effect, and the max fuel limit and torque limiter are disabled. This means the maximum fuel available is determined only by the Start Fuel Limit set point, and the speed reference is determined only by the idle speed set point.

When Rated Speed (high or fast idle) is selected by closing the Idle/Rated switch contact, the fuel limit is set to the Maximum Fuel Limit set point value or the Torque Limit, whichever is less for the current engine operating speed. The speed reference selected at this time is determined by the status of the Local/Remote switch. If Local is selected when the switch contacts are closed, the speed reference will ramp from low idle to fast idle (rated) speed, based on the Accel Time set point. Closing either the Raise or Lower contacts (or the Remote contacts) while ramping from idle to rated results in immediate cancellation of the idle to rated ramp.

After acceleration to rated speed is completed, the Raise and Lower commands increase and decrease engine speed based on the Raise and Lower Rate set points. The Raise and Lower Limits determine the limits of these commands.

If Remote is selected after the engine reaches rated speed, the control will ramp speed to the reference value set by the remote speed setting milliamp input based on the Raise or Lower Rate. The remote speed setting operates from 4 to 20 mA (1 to 5 Vdc). The values of the 4 mA and 20 mA Remote Reference set points must be set between the Raise and Lower Limit set points. The 4 mA Remote Reference set point may be set to a lower or higher speed than the 20 mA set point, providing for either direct or reverse-acting remote speed setting.

If Remote is selected when the Idle/Rated switch contacts are closed or during the idle to rated ramp, the speed reference will ramp to the speed reference value determined by the milliamps on the remote speed-setting input, based on the Raise Rate set point. This may not be the desired mode of operation, so be sure to understand the implications of operating the control in this manner.

Remote speed setting inputs between 2 and 4 mA (0.5 and 1 Vdc) are treated as the minimum of 4 mA (1 Vdc). Below 2 mA (0.5 Vdc), the remote input is considered failed. Between 4 and 20 mA (1 and 5 Vdc), the control determines the required speed reference based on a straight line between the 4 mA Remote Reference and 20 mA Remote Reference set points. If a difference is detected between the current speed reference and the remote reference computed from the mA input, the current speed reference is raised or lowered at the rate determined by the Raise or Lower Rate to bring the speed reference into agreement with the remote speed reference. The remote reference will not increase speed over the Raise Limit or lower it below the Lower Limit.

When the remote reference is selected, the remote input is failed (less than 2mA /0.5) Vdc, and the 4mA Setpoint option has been selected, the speed reference will ramp to the 4mA set point at the Raise Rate or Lower Rate set point.

When remote reference is selected, the remote input is failed (less than 2 mA/0.5 Vdc), and the lock-in-last option is selected, the speed reference remains at the current value. This also means that if the Idle/Rated switch is changed from idle to rated and Remote is selected with an input less than 2 mA (0.5 Vdc), speed will remain at idle. Speed will remain at idle until the remote input is increased to a value greater than 2 mA (0.5 Vdc), at which time speed will ramp based on the Raise Rate set point to the remote speed setting. (If Local is then selected under these conditions, speed will remain at idle until the Idle/Rated switch is changed to idle and back to rated to restart the ramp, since selection of the remote input cancels the accel ramp.)

When the current operating mode is Rated and either Local or Remote, switching to idle results in immediate switching of the fuel limiter to the start fuel limit, and ramping engine speed to idle based on the Decel Time set point.

Low Idle Offset

A Low idle offset (droop) feature is provided to reduce or prevent engine speed undershoot when reducing speed to low idle without using the time ramps. This is accomplished by increasing (offsetting) the speed reference upward proportional to rack movement below the normal low idle position.

Power Up Diagnostics

The Power Up Diagnostics feature is provided to verify the proper operation of the microprocessor and memory components. The diagnostics take about four seconds after the control is powered on. A failure of the test will turn off the output of the control. If diagnostic testing is successful, the CPU OK indicator on the control cover will light.

Chapter 6. Troubleshooting

General

The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, plant wiring, or elsewhere. Troubleshooting beyond this level is recommended ONLY when a complete facility for control testing is available.

NOTICE

The control can be damaged with the wrong voltage. When replacing a control, check the power supply, battery, etc., for the correct voltage.

Troubleshooting Procedure

Table 6-1 is a general guide for isolating system problems. This guide assumes that the system wiring, soldering connections, switch and relay contacts, and input and output connections are correct and in good working order. Make the checks in the order indicated. Each system check assumes that the prior checks have been properly done.

Control Test and Calibration

General

Do the following checks on the 701A Control. Then verify the functioning of set points and adjustments.

1. Connect the Hand Held Programmer to the control in accordance with the instructions in Chapter 3. Verify that correct voltage and polarity are applied to the control. Verify that the programmer does its power-up tests. Failure to do the power up test indicates either the control or Hand Held Programmer has failed. Replace the control or Hand Held Programmer.

2. Press the ID key. The message “Woodward 701A P/N 5412-659” should appear. Failure indicates either the control or Hand Held Programmer has failed. Replace the control or Hand Held Programmer.

3. Select Menu 0. Step through the menu to the Diagnostics Results step. Verify that the displayed value is 49. If any other value is displayed, replace the control.

4. Select Menu 1. Verify that all set points are as recorded during installation. Repeat for Menus 2, 3, 4, and 5. If any differences are found, change the set point(s) to the correct value. Press the SAVE key. The message “Set Points Saved” should be displayed. Remove power from the control for at least 10 seconds. Verify correct values were retained during power down. Failure indicates the control has failed and should be replaced.

Discrete Inputs

Do the following test to verify the function of the Discrete Inputs. Don't do these tests with the engine in operation.

1. Close the Run/Stop contact or apply 24 Vdc between terminals 8(-) and 9(+) to select Run. Select Run/Stop Contact on Menu 9. The status should be closed. If the value does not change from closed to open when the Run/Stop contact is opened, verify the voltage at the control terminals. If correct voltage is verified, the control has failed and should be replaced.

2. Close the Idle/Rated contact or apply voltage to terminal 10(+). The Idle/Rated Contact Status should change from closed to open when the voltage is removed.

3. Continue as above with the Lower contact, terminal 11.

4. Continue as above with the Raise contact, terminal 12.

5. Close the Remote contacts, terminals 11 and 12. Local/Remote Contact Status should be Remote. If not, check 3 and 4 above to determine which input is incorrect.

6. Continue as above with the Alternate Dynamics contact, terminal 13.

7. Continue as above with the Failsafe Override contact, terminal 14.

   Any discrete input with power applied should indicate a closed status. If proper voltage is determined at the terminal strip, failure indicates the control input is bad. Replace the control.

Remote Input

The following tests calibrate and verify the function of the Remote Input, Analog Input 1.

1. Connect a 4 to 20 mA or 1 to 5 Vdc source to terminals 18(+) and 19(-). If a mA source is used, a jumper must be installed across terminals 17 and 18. Connect a dc voltmeter across terminals 18(+) and 19(-). Optionally, a mA meter may be installed in series with the 4 to 20 mA source.

2. Set the source for 5.0 Vdc (20.0 mA) on the meter. Select Menu 6 on the Hand Held Programmer.

3. Set the Calibration Key to 49. Select Remote In(put) Cal(ibration) on Menu 6.

4. Verify that the display reads 20.00 ± 0.01 mA.

5. Set the source for 1.0 Vdc (4.0 mA). The Remote Input value should be 4.0 mA ± 0.2 mA. If the meter indicates proper voltages (or currents) are present on the Analog Input 1, but readings on the Hand Held Programmer are incorrect, the 701A control is defective and should be replaced.

Aux Input

The following tests calibrate and verify the function of the Aux Input, Analog Input 2.

1. Connect a ±2.5 Vdc source to terminals 21(+) and 22(-). Connect a dc voltmeter across terminals 21(+) and 22(-).

2. Set the source for 0.0 Vdc on the meter. Select Menu 6 on the Hand Held Programmer.

3. Set the Calibration Key to 49. Select Aux Input Cal(ibration) on Menu 6.

4. Verify that the display reads 0.0 ± 0.01 Vdc.

5. Set the source for +2.5 Vdc on the meter. Select Aux Input Cal. The value should be +2.5 ± 0.2 Vdc. If the value is exactly +2.5 Vdc, reduce the input until the reading is between +2.5 and +2.4 Vdc. The input should not be less than +2.25 Vdc.

6. Set the source for -2.5 Vdc. The Aux Input Cal value should be -2.50 ± 0.15 Vdc. If the value is exactly -2.5 Vdc, adjust the input until the reading is between -2.5 and -2.4 Vdc. The input should not be beyond -2.25 Vdc. If the voltmeter indicates proper voltages are present on the Analog Input 2, but readings on the Hand Held Programmer are incorrect, the 701A control is defective and should be replaced.

Actuator Output

The following tests verify the actuator output of the control.

1. Select Run/Stop Contact Status closed and Failsafe Override Cont. St. closed (terminals 9 and 14 have the correct voltage applied). Connect a milliamp meter across terminals 3(+) and 4(-) if no actuator is connected. Connect the milliamp meter in series with the actuator if one is connected to the control. (Alternately, a dc voltmeter may be connected across the output, terminals 3(+) and 4(-), when an actuator is connected. The correct output currents must be computed using the voltage measured and the input resistance of the actuator.)

2. Select Menu 5 on the Hand Held Programmer. Set the Configuration Key to “49”.

3. Select Actuator Sense on Menu 5, and select Forward Acting.

4. Select the Start Fuel Limit set point on Menu 4. Set Start Fuel Limit to 20%. The output current should be 42 ± 2 mA (4.2 ± 0.2 mA for the 20 mA output versions of the 701A control).

5. Set the Start Fuel Limit to 100%. The output current should be 210 ± 10 mA (21 ± 1 mA for the 20 mA output versions of the 701A control). If with all connections verified, the control output does not operate as above, replace the control.

Speed Input

The following tests verify the operation of the Speed Input.

1. Connect an audio frequency signal generator to the speed signal input. Set the output level above 1.0 Vrms. Set the Num Gear Teeth set point on Menu 5 to 60 (this causes the rpm values and Hertz values to be the same for ease of doing the tests).

2. Set the signal generator to 120 Hz. Read Engine Speed value of 120 rpm on Menu 7. Increase the signal generator frequency to 1000 Hz. The value read should follow the signal generator frequency.

NOTICE **To prevent possible damage to the engine, return the number of gear teeth to the correct value.**

Aux Output

The following tests calibrate and verify the operation of the Aux Output.

1. Connect a mA meter across the Aux 4-20 mA Output, terminals 5(+) and 6(-). Select Menu 5 on the Hand Held Programmer.

2. Set the Configuration Key to 49. Select Aux Output on Menu 5, and select Actuator Percent.

3. Select Actuator Output on Menu 7 on the second line of the display and record the value shown.

4. Select 20ma Aux Actuator output on Menu 4 on the second line of the display and record the value. Then set to the same value recorded in step 3.

5. Set Calibration Key to 49 on Menu 6.

6. Select Aux Output Cal(ibration) on Menu 6 and update the value on the meter by pressing the up or down arrow until the meter reads 20.00 ± 0.01 mA.

IMPORTANT **If 4ma Aux Actuator and 20ma Aux Actuator are the same value, the Aux Output will be 0 mA.**

7. Select 20ma Aux Actuator on Menu 4 and reset to the original value recorded in step 4.

8. Select 4ma Aux Actuator on Menu 4 and record the value. Then set to the same value recorded in step 3. The mA meter should read 4.0 ± 0.1 mA. Failure of this test indicates a faulty 701A control, which should be replaced.

9. Select 4ma Aux Actuator on Menu 4 and reset to the original value recorded in step 8.

Conclusion of Test and Calibration Procedures

This completes the test and calibration chapter. Save the set points by pressing the SAVE key on the Hand Held Programmer. Power down the control for about 10 seconds. Restore power and verify that all set points are as recorded.

NOTICE

To prevent possible damage to the engine resulting from improper control settings, make sure you save the set points before removing power from the control. Failure to save the set points before removing power from the control causes them to revert to the previously saved settings.

Disconnect the Hand Held Programmer from the control. Close the cover over J1 and retighten the retaining screw.

⚠WARNING

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

Table 7-1. System Troubleshooting

Problem	Cause	Remedy
Engine will not start. Actuator not moving to start fuel position. **IMPORTANT** **If the actuator moves to start position, a problem with the engine fuel supply is indicated.**	Supply voltage polarity reversed, or no supply voltage.	Check for supply voltage from terminals 1(+) to 2(-). Reverse leads if polarity is incorrect.
	Actuator not responding to input signal from control. **IMPORTANT** **The pneumatic actuator must have air pressure to operate (respond).**	If there is a voltage output at control terminals 3(+) and 4(-), but the actuator does not move, check the wiring to the actuator for opens or shorts. With the EG-P actuators, remember that terminals C and D of the mating plug should be jumpered. Make resistance checks at the actuator. Coil resistance is approximately 35 ohms. (Read with leads at T3 and T4 disconnected.)
	Start fuel limit set too low.	Increase start fuel limit until engine starts. Check actuator and linkage for proper installation and operation. Problems may be oil supply, air supply, direction of rotation, insufficient drainage, linkage, worn actuator components, or improper adjustment.
	No actuator voltage at terminals 3 and 4.	Check for shorted or grounded actuator leads by removing wires to terminals 3 and 4. Check for at least 1 Vrms at terminals 15 and 16, and at least 6% of the maximum speed frequency range.
	Speed setting too low on initial start.	Speed setting may be lower than cranking speed. With Idle/Rated contact open, increase Idle Speed (Menu 3). **NOTICE** **If adjusting Idle Speed does not produce the correct output, return Idle Speed setting to normal start position**.

Problem	Cause	Remedy
Engine will not start. Actuator not moving to start fuel position. (cont.)	Minimum Fuel contact open.	Check T9. Minimum Fuel contact must be closed for normal operation. Check for 18 to 40 Vdc from terminal 9(+) to 8(-).
	Speed sensor signal not clearing failed speed signal circuit.	Check wiring for proper connection. Check shields for proper installation. Speed sensor not spaced properly. Check for at least 1.0 Vac and 6% rated speed at terminals 15 and 16 during cranking. If less than 1.0 Vac or 6% rated speed, magnetic pickup may be spaced too far from gear. Make sure there are no metal chips on end of pickup. If no voltage is present, magnetic pickup may be open-circuited or shorted. Make resistance check with the leads disconnected from control. Should be about 100 to 300 ohms. Failed speed-signal circuit may be disabled by connecting 18 to 40 Vdc to terminal 14. **⚠WARNING** **Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.**
	Faulty 701A control.	Replace control.
Engine overspeeds only on starts.	Accel Time adjustment.	Increase Accel Time. This decreases acceleration rate (from low idle to rated).
	Rated Speed setting too high.	Set Rated Speed as described in Chapter 3.
	Control adjustment.	Control may be adjusted for sluggish operation causing overspeed on start. Slowly adjust GAIN for fastest stable response. STABILITY may be adjusted too low. Increase STABILITY setting.
	Determine if engine is malfunctioning.	Verify that fuel rack is not binding and linkage is properly adjusted. It may be necessary to determine if the fuel rack is quickly following the actuator input voltage. Verify proper operation of overspeed protection devices to determine if a shutdown is occurring without an overspeed condition.
	701A control.	If the control does not cut back the actuator voltage (T3 and T4), the 701A control may be faulty. If the voltage is cut back, look for a problem in the linkage or actuator.

Problem	Cause	Remedy
Engine overspeeds after operating at rated speed for some time.	Engine.	Check for proper operation of engine fuel system. If actuator moves toward minimum fuel during overspeed, problem is in fuel system.
	Magnetic pickup and 701A control.	Check the magnetic pickup output voltage at speeds above idle, at least 1.0 Vrms. If magnetic pickup should fail and the speed-signal-override-failed circuit is disabled, the 701A control will call for maximum fuel.
Engine stops and CPU OK indicator is off after operating at rated speed for some time.	701A power supply was disrupted.	Turn off power to the 701A control for at least 10 seconds. If the CPU OK indicator illuminates within 5 seconds after power is reapplied, power was disrupted.
	701A control.	Turn off power to the 701A control for at least 10 seconds. If the CPU OK indicator does not illuminate within 5 seconds after power is reapplied, the problem is in the 701A control.
Low speed is not regulated at idle speed.	Actuator and linkage. ***IMPORTANT*** **On carbureted engines, the minimum fuel stop rpm setting will vary with engine temperature. An improper cold setting may give interference with the Idle Speed setting when the engine is hot.**	The Idle Speed setting may be below the minimum-fuel position of the actuator or engine fuel stop. The engine will be maintained at the minimum-fuel position by the actuator or the engine minimum-fuel stop. These conditions indicate that the engine minimum-fuel position should be decreased by linkage adjustment (diesel engine) or low-idle set screw (gas engine), or the Idle Speed setting should be raised. If this action does not correct the problem, the 701A control may be faulty.
Engine does not decelerate when Rated contact is open.	Faulty Rated contact.	Check Rated contact. Remove wire from terminal 10. Engine should decelerate.
	701A control ramp circuitry.	A faulty Rated contact may remain in the accelerate position with the contact open. If the Rated contact is operative, loss of idle control may be due to a faulty circuit.
Engine will not stabilize at rated no-load speed. The instability may occur at no load or it may vary with load. Control may be erratic.	701A control.	Adjust GAIN, STABILITY, and COMPENSATION as described in Chapter 3.
	Improper linkage adjustment.	Make sure that the actuator moves approximately 2/3 of its travel from no load to full load. Be sure linkage is linear on turbine, diesel, and fuel-injected engines. Be sure linkage is nonlinear on carbureted engines. Refer to actuator manual for proper installation.

Problem	Cause	Remedy
Engine will not stabilize at rated no-load speed. The instability may occur at no load or it may vary with load. Control may be erratic. (cont.)	Necessary external wires not properly shielded. (Electrical noise, caused by wiring carrying an ac voltage, stray magnetic fields from transformers, etc., can be picked up by improperly shielded wire. Noise will cause instability if picked up by magnetic pickup lines and actuator lines.)	The following tests will isolate noise and interference. Verify that the switchgear frame, governor chassis, and engine have a common ground connection. Temporarily remove the battery-charger cables from the control battery system. Remove all wires except the battery, speed sensor, and actuator wires. Close the necessary discrete inputs. If the prime-mover operation is significantly improved by these modifications, replace the wires one at a time to locate the source of the trouble. External wiring may require additional shielding or rerouting from high-current lines or components. If the problem cannot be solved by these checks, it will be necessary to remove the 701A control from the switchgear. Temporarily mount the control next to the engine and connect only a battery, magnetic pickup, necessary discrete inputs, and actuator to the control (use a separate battery placed next to the engine). After starting the engine, if necessary, apply load to check stability. If stability occurs when the control is mounted next to the engine, return the control to the switchgear. Run new magnetic pickup, actuator, and battery power lines. Shield all wires to the control. Route all wires through conduit or an outer shield. Tie the outer shield to system ground at the end opposite to the control.
	Engine may not be receiving fuel as called for by the actuator voltage.	Check actuator linkage to fuel-controlling mechanism for any lost motion, binding, or excessive loading. Verify a steady fuel pressure of proper value. Check actuator per appropriate actuator manual.
	Engine not operating properly.	Engine may be causing speed variations. Control engine manually to determine if instability is in engine or governor control. Verify proper adjustment of fuel control linkage.
	Input voltage low.	Check supply voltage. It should be at least 18 or 88 Vdc or 90 Vac.
	Actuator.	If actuator has a ballhead backup, verify that its hydraulic governor section, speed setting, and speed droop adjustments are properly set (see the applicable governor manual).
Engine does not maintain constant speed (isochronous).	Engine.	If droop occurs near the full-load point only, it is possible the engine is not producing the power called for by the fuel control, or is being overloaded. Either is indicated if the fuel control is at maximum position.
	701A Control.	Check Max Fuel Limit setting. Increase if required. Check Torque Limiter settings. Increase if required. Check droop setting. Set to 0 if required.

Chapter 7.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used In Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Engine Model Number

Number of Cylinders

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.)

Power Output Rating

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Symptoms

Description

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix.
Programming Checklist

We recommend you write down the final value of each menu item here so you will have a record if you later need to reprogram or replace the control.

_____ Software Part Number and Revision Letter

1 — Dynamics Menu

_____ 1. Gain 1
_____ 2. Stability 1
_____ 3. Compensation 1
_____ 4. Gain Ratio 1
_____ 5. Window Width 1
_____ 6. Gain Breakpoint 1
_____ 7. Gain Slope 1

2 — Alternate Dynamics Menu

_____ 1. Gain 2
_____ 2. Stability 2
_____ 3. Compensation 2
_____ 4. Gain Ratio 2
_____ 5. Window Width 2
_____ 6. Gain Breakpoint 2
_____ 7. Gain Slope 2

3 — Speed Setting Menu

_____ 1. Raise Limit
_____ 2. Lower Limit
_____ 3. Idle Speed
_____ 4. Accel Time
_____ 5. Decel Time
_____ 6. Raise Rate
_____ 7. Lower Rate
_____ 8. 20ma Remote Ref
_____ 9. 4ma Remote Ref
_____ 10. 20ma Tach RPM
_____ 11. 4ma Tach RPM
_____ 12. Droop
_____ 13. Idle Breakpoint
_____ 14. Idle Droop
_____ 15. Torsional Filter

4 — Fuel Limiters and Control Output Menu

_____ 1. Max Fuel Limit
_____ 2. Start Fuel Limit
_____ 3. Start Speed
_____ 4. Idle Fuel Limit
_____ 5. Torque Limit BP
_____ 6. Min Torque Limit
_____ 7. BP Torque Limit
_____ 8. Max Torque Limit
_____ 9. 20ma Aux Actuator
_____ 10. 4ma Aux Actuator

5 — Configuration Menu

_____ 1. Configuration Key
_____ 2. Rated Speed
_____ 3. Num Gear Teeth
_____ 4. Num Samples
_____ 5. Engine Type
_____ 6. Actuator Sense
_____ 7. Dynamics Map
_____ 8. Remote Fault
_____ 9. Speed Sense
_____ 10. Aux Output

6 — Configuration Menu

_____ 1. Calibration Key
_____ 2. Remote In Cal
_____ 3. Aux Input Cal
_____ 4. Aux Output Cal

7 — Display Menu 1

_____ 1. Engine Speed
_____ 2. Speed Reference
_____ 3. Actuator Output
_____ 4. Aux Output
_____ 5. Remote Input
_____ 6. Aux Input
_____ 7. Control Mode

9 — Display Menu 2

_____ 1. Run/Stop Contact
_____ 2. Idle / Rated
_____ 3. Lower Speed
_____ 4. Raise Speed
_____ 5. Dynamics Switch
_____ 6. Failsafe Override

0 — Status

_____ 1. Watchdog Status
_____ 2. Diagnostics Result
_____ 3. ROM Checksum

701A Menu Summary

1. — Dynamics Menu
1. Gain 1
2. Stability 1
3. Compensation 1
4. Gain Ratio 1
5. Window Width 1
6. Gain Breakpoint 1
7. Gain Slope 1

2 — Alternate Dynamics Menu
1. Gain 2
2. Stability 2
3. Compensation 2
4. Gain Ratio 2
5. Window Width 2
6. Gain Breakpoint 2
7. Gain Slope 2

3 — Speed Setting Menu
1. Raise Limit
2. Lower Limit
3. Idle Speed
4. Accel Time
5. Decel Time
6. Raise Rate
7. Lower Rate
8. 20ma Remote Ref
9. 4ma Remote Ref
10. 20ma Tach RPM
11. 4ma Tach RPM
12. Droop
13. Idle Breakpoint
14. Idle Droop
15. Torsional Filter

4 — Fuel Limiters and Control Output Menu
1. Max Fuel Limit
2. Start Fuel Limit
3. Start Speed
4. Idle Fuel Limit
5. Torque Limit BP
6. Min Torque Limit
7. BP Torque Limit
8. Max Torque Limit
9. 20ma Aux Actuator
10. 4ma Aux Actuator

5 — Configuration Menu
1. Configuration Key
2. Rated Speed
3. Num Gear Teeth
4. Num Samples
5. Engine Type
6. Actuator Sense
7. Dynamics Map
8. Remote Fault
9. Actuator Sense
10. Aux Output

6 — Calibration Menu
1. Calibration Key
2. Remote In Cal
3. Aux Input Cal
4. Aux Output Cal

7 — Display Menu 1
1. Engine Speed
2. Speed Reference
3. Actuator Output
4. Aux Output
5. Remote Input
6. Aux Input
7. Control Mode

9 — Display Menu 2
1. Run/Stop Contact
2. Idle / Rated
3. Lower Speed
4. Raise Speed
5. Dynamics Switch
6. Failsafe Override

0 — Status
1. Watchdog Status
2. Diagnostics Result
3. ROM Checksum

701A Control Specifications

Woodward Part Numbers:	
8280-192	701A w/ MPU, low-voltage power supply, 0-200 mA output
8280-193	701A w/ MPU, high-voltage power supply, 0-200 mA output
8280-194	701A w/ MPU, low-voltage power supply, 0-20 mA output
9907-205	Hand Held Programmer
Power Supply Rating	18–40 Vdc (24 or 32 Vdc nominal) 88–132 Vac 50/60 Hz (120 Vac nominal) 90–150 Vdc (125 Vdc nominal)
Power Consumption	8 watts nominal
Steady State Speed Band	MPU: 60–15 000 Hz (8–2100 rpm) proximity switch: 7.5–1000 Hz (8–2100 rpm)
Remote Speed Setting Input	4–20 mA
Tachometer Output	4–20 mA
Ambient Operating Temperature	–40 to +70 °C (–40 to +158 °F)
Storage Temperature	–55 to +105 °C (–67 to +221 °F)
EMI/RFI Specification	US MIL-STD 461C (Parts 5 & 9)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 02814A.

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